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HARVARD COLLEGE
FEB 12 1891

THE ELECTRICAL REVIEW

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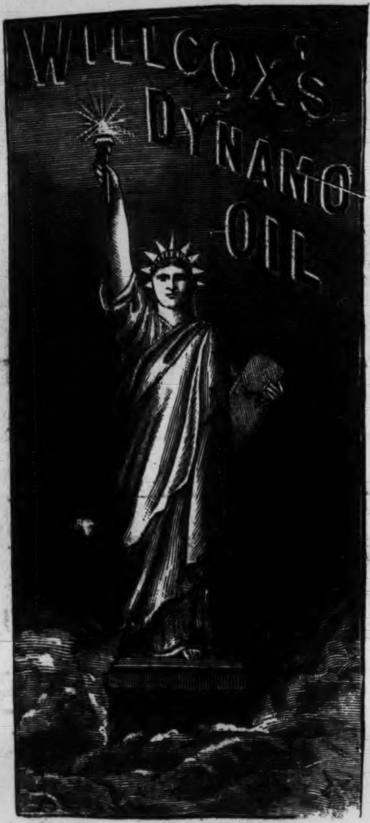

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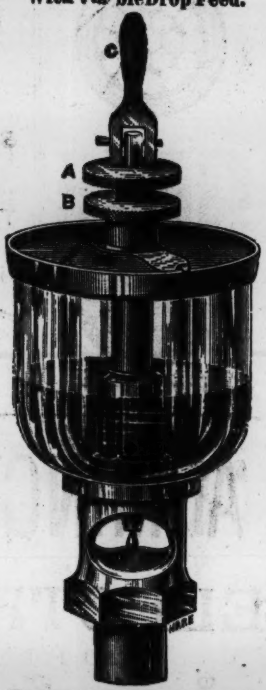

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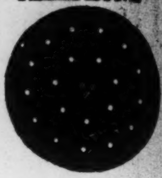

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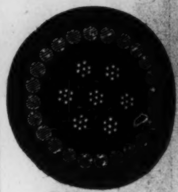

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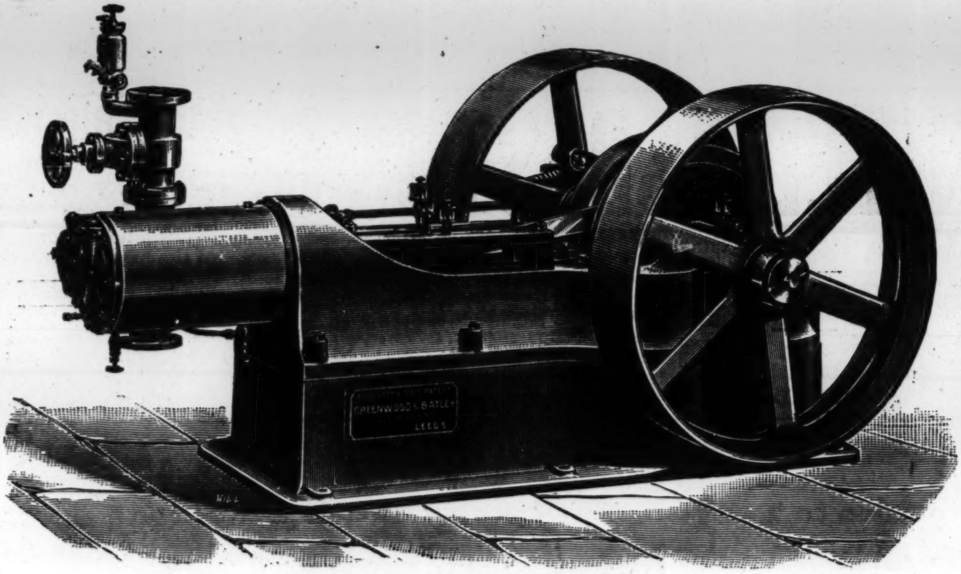

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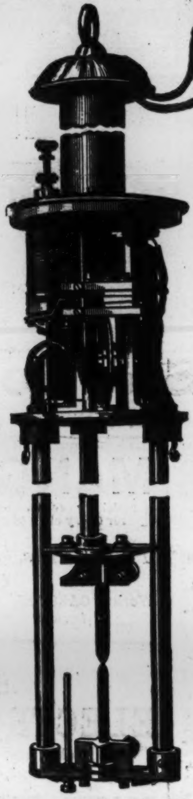

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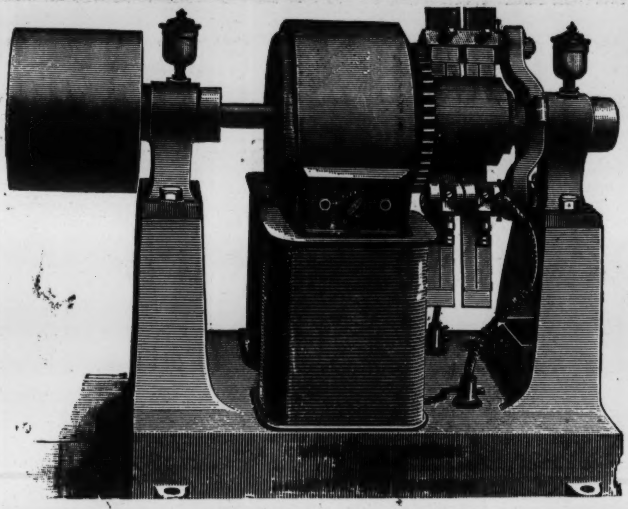

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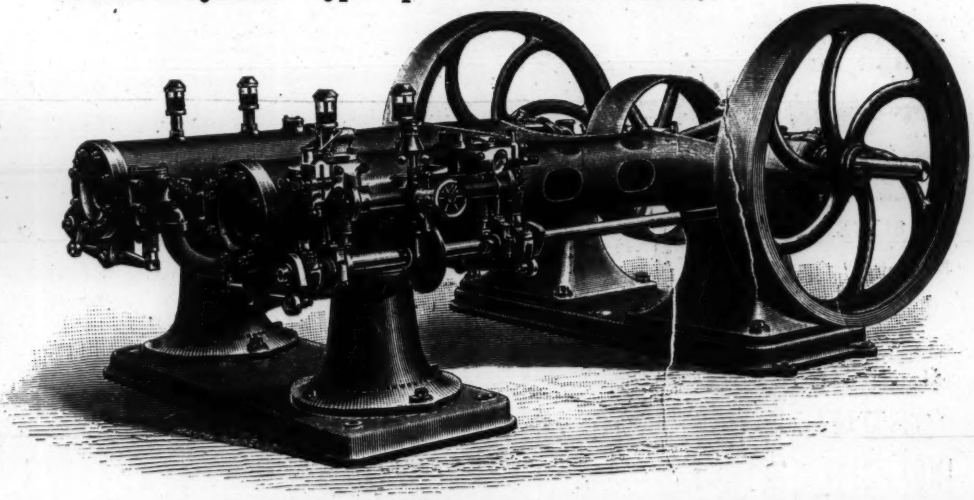

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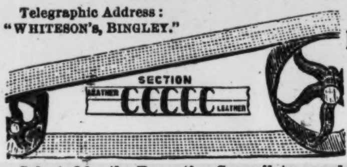

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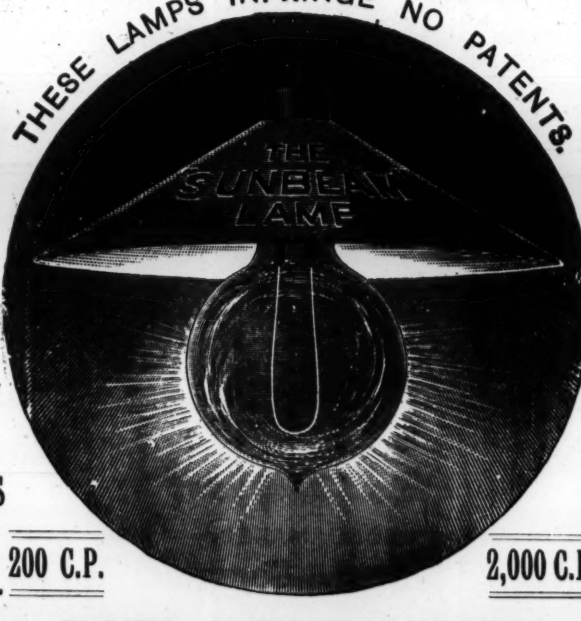
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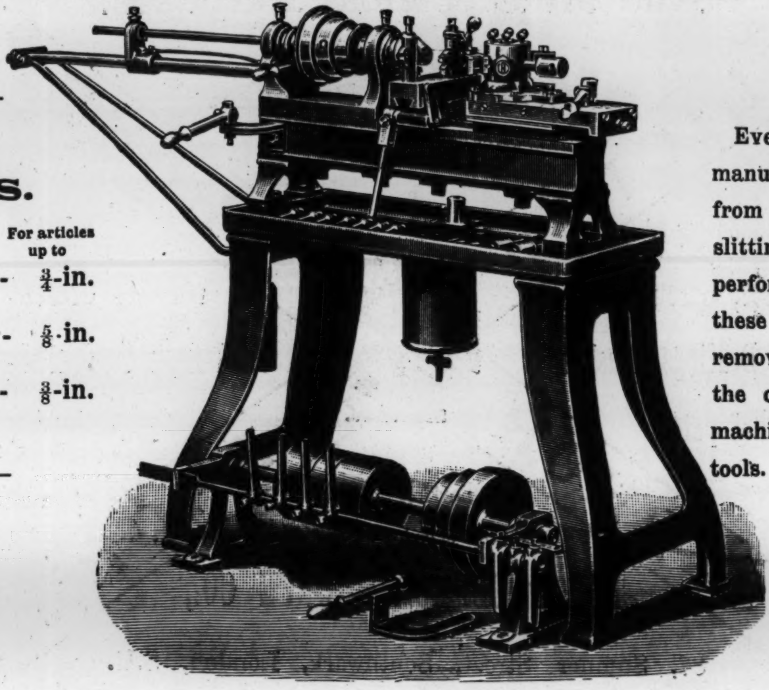

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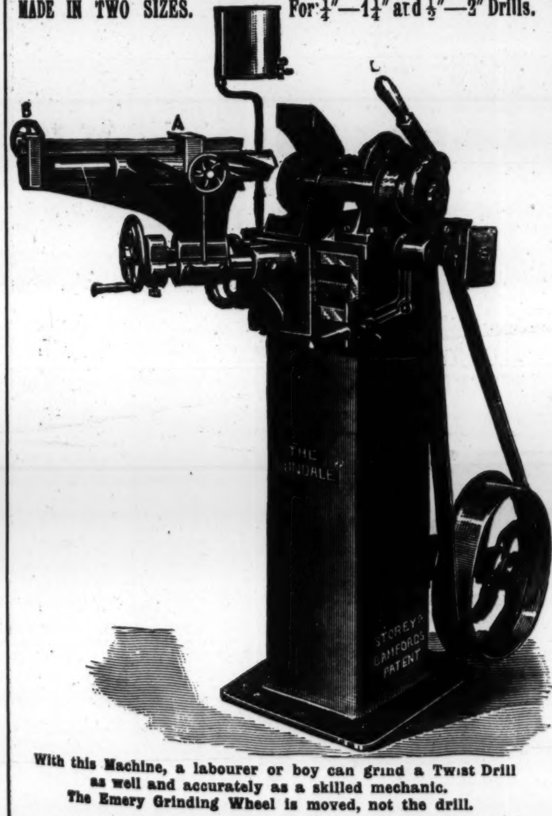

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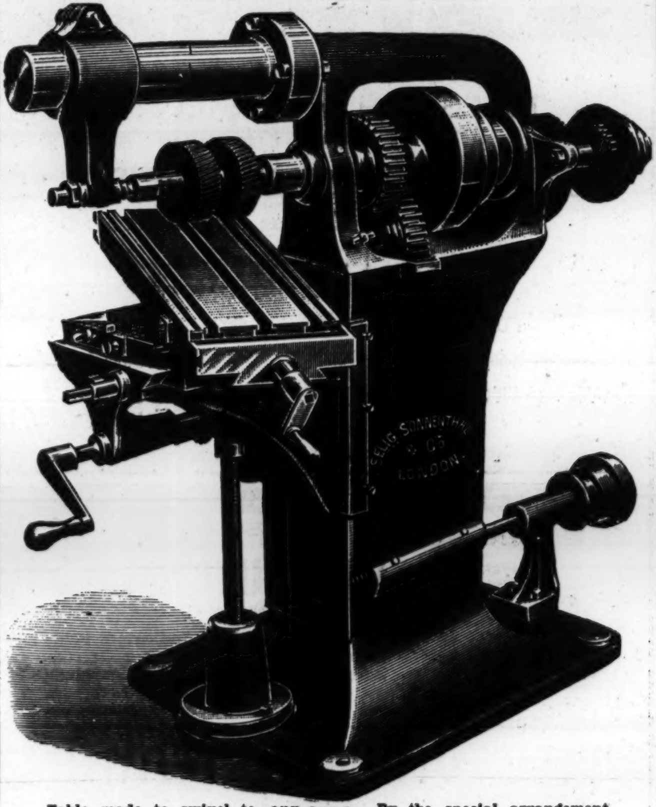

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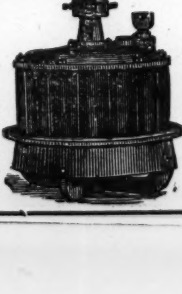

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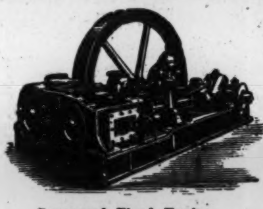

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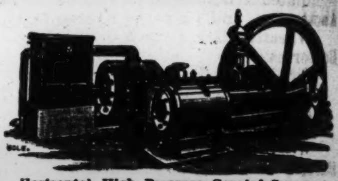

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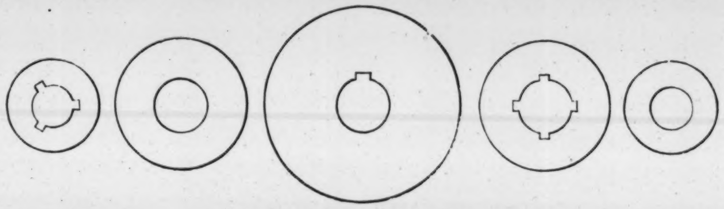

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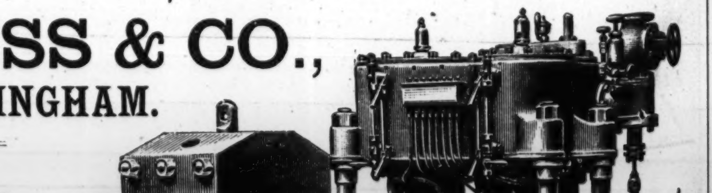

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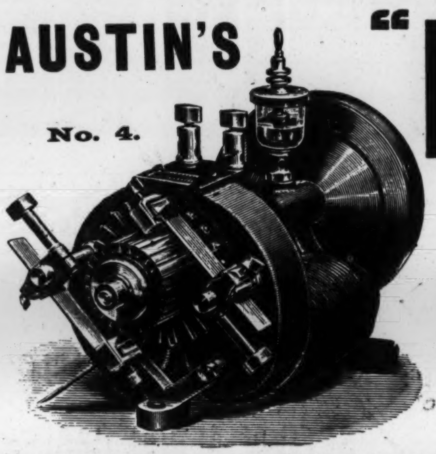

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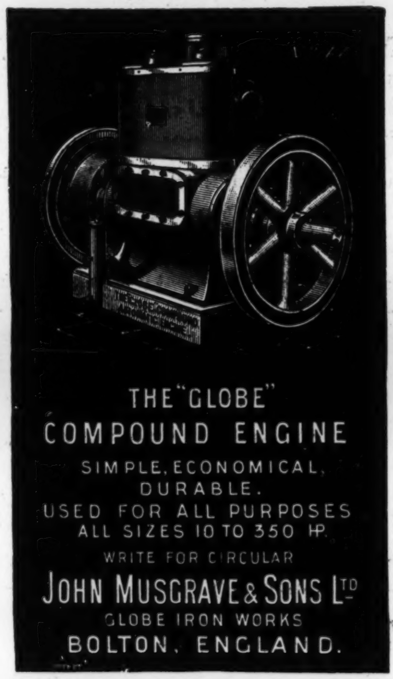

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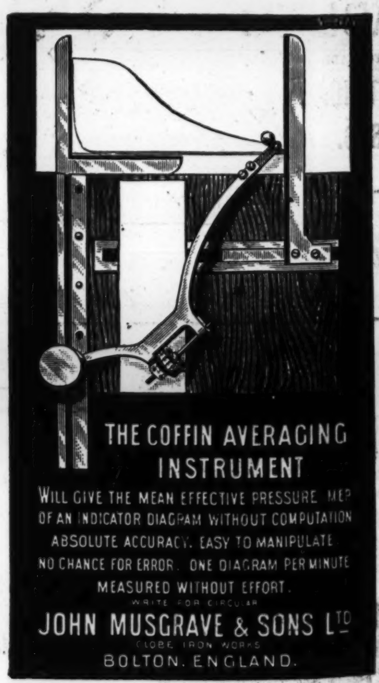

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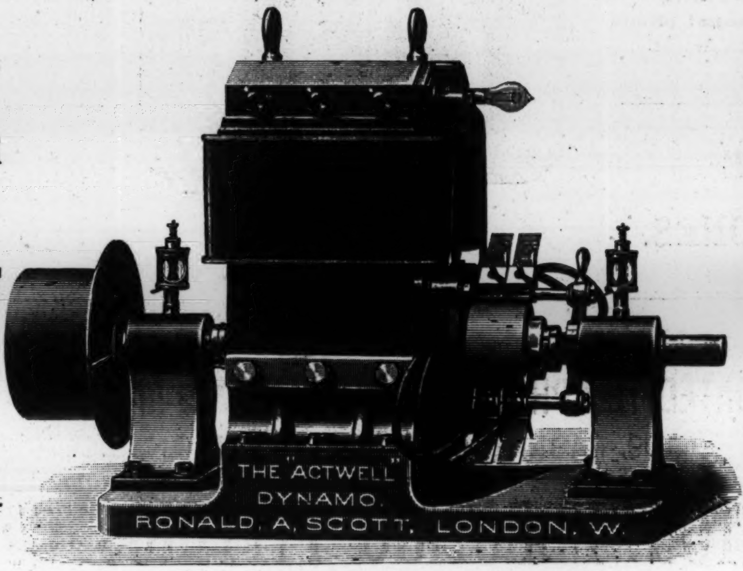

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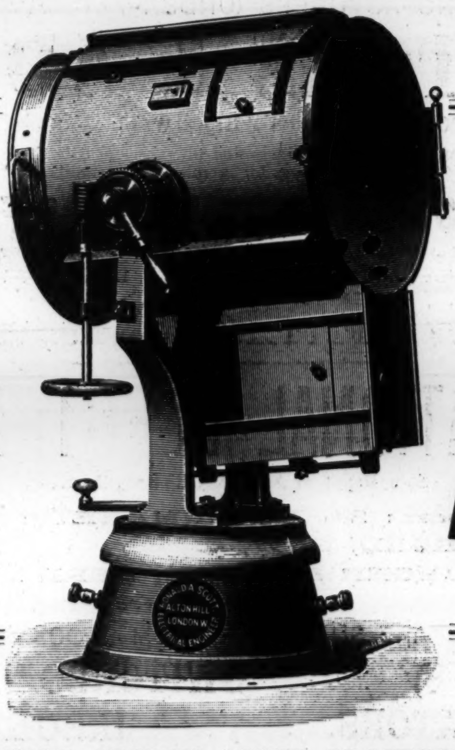

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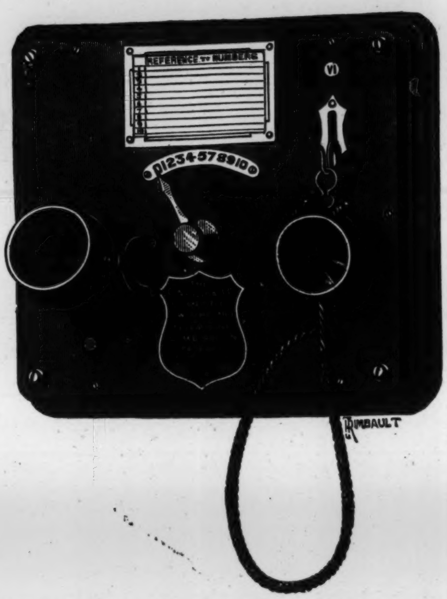

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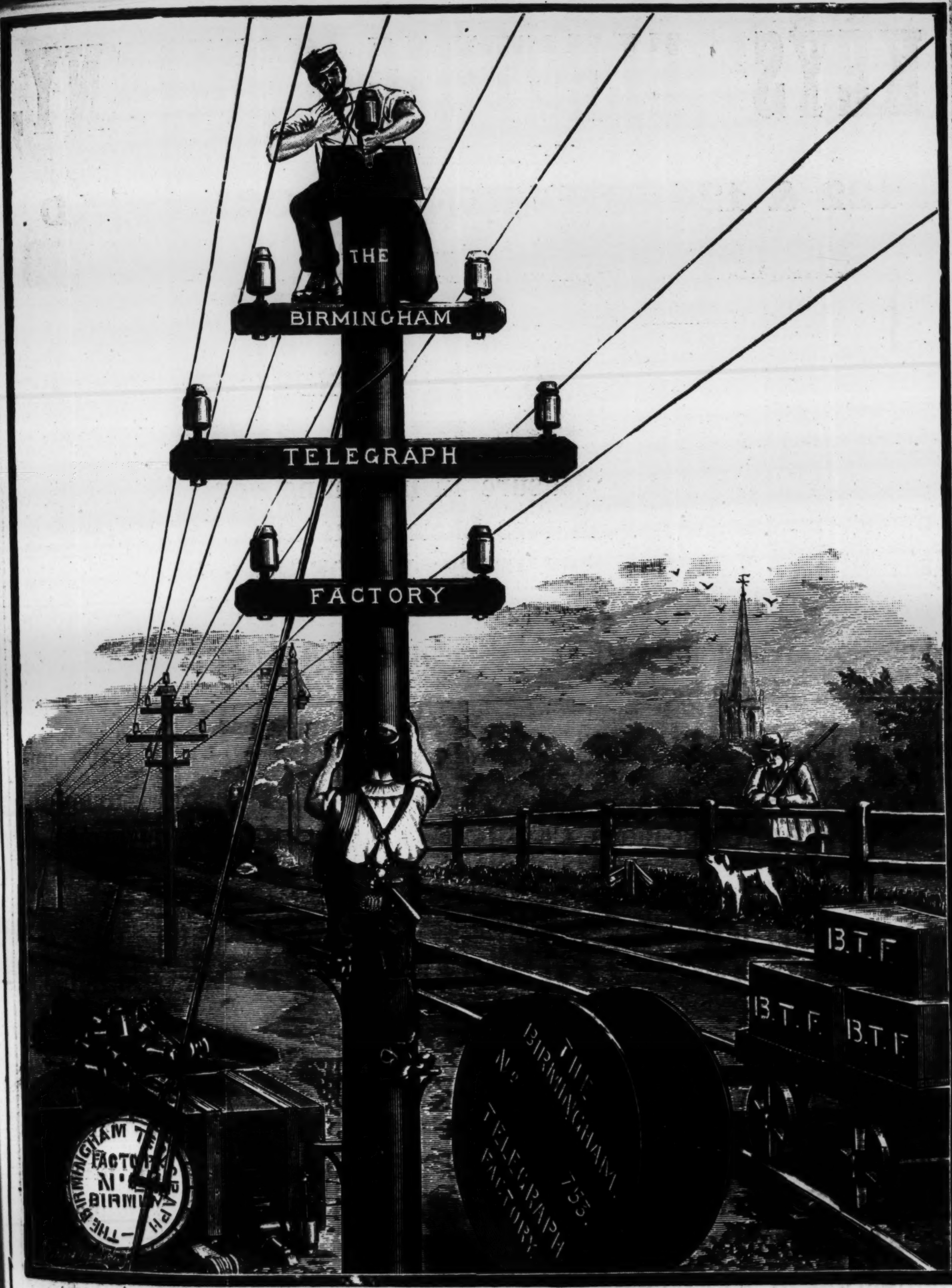
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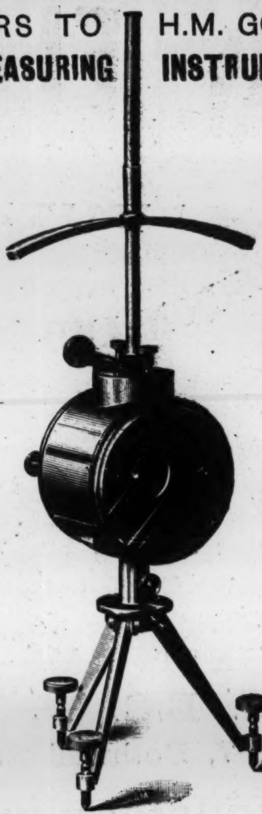

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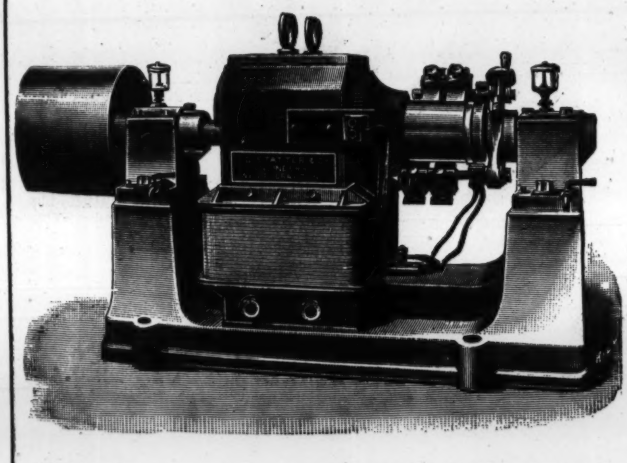

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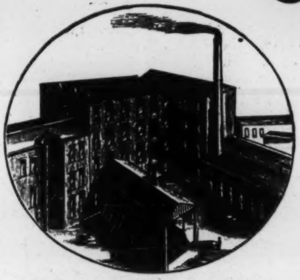

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THE EFFICIENCY AND DEPRECIATION OF INCANDESCENCE LAMPS.

OWING to the rapid extension of electric lighting in London during the past year or two, the question of the efficiency and depreciation of the incandescence lamp has become more prominent. In London alone at the present day, there are probably some 200,000 lamps at work, reckoned irrespective of their candle-power, and the renewals of these will not be far short of the same number yearly.

With the exception of the high candle-power lamps, the manufacture is practically a monopoly of the Edison-Swan Company, and it is only fair to say that they have carried out their work thoroughly. Charging a high price, and being free from any competition, they have been enabled to devote their attention to the production of a standard article, and owing to the careful tests made, there is little or no difference to be found in any batch of lamps.

For the last few years there has been no marked improvement in the filament itself, any alterations made being confined to the attachment of the filament to the platinum contacts, the globe and the outside fittings.

A test of these lamps was published in the REVIEW of January 16th, and it may be useful to refer to it again, and note the relation of candle-power and energy consumed throughout the thousand hours.

Hours.	C.P.	Watts.	Total watts.
0	19·3	3·34	64·46
100	18·8	3·45	64·86
200	17·2	3·79	65·19
300	15·6	4·1	63·96
400	15·2	4·17	63·38
500	14·8	4·29	63·49
600	14·4	4·38	63·07
700	14·1	4·5	63·45
800	13·3	4·68	62·24
900	12·4	4·9	60·76
1,000	12	5	60

The mean candle-power for this life works out at 15·2, being 78·8 per cent. of the initial candle-power. The average watts per candle are 4·15, and this agrees closely with the manufacturers' rating of 4 watts. Starting at 19·3, the candle-power falls slowly over the first 100 hours, then more rapidly, and reaches the normal after 275 hours' run; from that time the decrease is more gradual, the mean of 15·2 candles being passed at 400 hours. The resistance "hot" of the lamp rises from 155 to 166 ohms, owing to particles of carbon being removed from the filament and deposited on the surrounding glass. This rise of resistance and consequent diminution of energy consumed and light developed is not great, and it is doubtful whether the actual temperature and light emission of the carbon is much reduced. Probably the greater part of the loss of light is due to the blackening of the glass, and it is this gradual obstruction of the light, and not so much the falling off of the light itself, that renders the lamp inefficient.

Suppose a test to be made on the same lamps with an initial consumption of 3·75 watts per candle, the curve would probably start from 17, pass the normal at about 500 hours, and finish the 1,000 hours at 15 candles with a consumption of 4¼ watts per candle. An average of 16 candles would be obtained with a consumption of 4 watts per candle. It would be of the greatest interest to carry out a test on these lines, as these lamps would be the more efficient of the two.

A lamp rated at a high efficiency gives a high candle-power with a low consumption for about a third of its life only, but owing to excessive blackening of the glass does the remaining two-thirds with a low candle-power and large consumption.

It seems that the point to aim at for true economy is to reduce the steepness of the curve and make it approximate, as nearly as possible to the normal line, to sacrifice part of the light at first for the sake of the light towards the end of the run.

An interesting experiment is to take two lamps, one of 95 volts and the other of 100 volts, and place them side by side on the same fitting supplied at 100 volts. After the first 100 hours or so little difference is perceptible between the two; later on the 100-volt lamp will be the more brilliant, until the 95-volt lamp comes to an untimely end. Of the two the 100-volt lamp, light for light, will have consumed less energy. So that even if the lamps could be bought at a cheaper rate it would not pay to overrun them, as after the first 100 hours the more brilliant lamp places itself on a level with the ordinary one and falls off more rapidly after. Considering that the price charged to smaller customers who cannot obtain their lamps direct varies from 4s. 6d. to 6s. the question of life is a serious one.

Even with the present rating great annoyance is caused by the unevenness of the light. Nothing is more unsightly than a group of lamps some of which are bright and others dull. A new installation will start 20 per cent. above the normal brilliancy, and, assuming that all the lamps last through 1,000 hours, will fall 25 per cent. below, *i.e.*, the total illumination will be reduced by one-third, and not until the lamps have been replaced once or twice, and their ages thoroughly mixed up, will the illumination rise nearly to the normal again.

For ordinary purposes the temperature of the filament could not be increased without the light becoming painfully bright. It would then have to be removed to a greater distance or carefully shaded, and there would be no real gain.

In practice, a further loss of light is occasioned by the lamps being allowed to become covered with dust. People who take care to have their windows kept clean in order to avail themselves of a full share of the light for which they do not pay, neglect to do the same with their lamps, although this method of illumination is more expensive. If lamps were taken out at intervals, and the glasses rubbed clean, a marked difference would be apparent. Again, in many cases, the lamps are hung downwards in close fitting shades, without any possibility of ventilation, so that the lamp socket and holder become considerably heated, the plaster loosened, and the lamp rendered useless. Such shades should be supported by open carriers, to allow free circulation of air.

Sometimes lamps are worked in as part of the ceiling decoration, and if this be in light colours, the effect is disastrous, as the circulation of air round the heated lamp deposits a ring of dirt at that spot.

Fittings for lamps should be simple and not heavy; the lamp in itself is a beautiful object. These should have efficient ventilation, and be kept clean.

A PERMANENT ELECTRICAL MUSEUM.

WE understand that a proposal is likely to be made to set apart a room of the new premises of the Institute of Electrical Engineers for a museum of electrical apparatus.

No one will suspect us of having any other desire than that of promoting the permanent interests of the electrical industry, but for more than one reason we very much doubt the wisdom of incurring the expense which the collecting, housing, and maintaining a museum of electrical apparatus would involve.

We have had the advantage of discussing the matter with an old member of the Society of Arts, one whose memory does not hark back quite so far as the period 1823—1825, when electro-magnetism came under the official cognisance of the Society of Arts, but who nevertheless has a lively memory of the time when the model room was a distinctive feature of that Society, and the electro-magnetic apparatus of Marsh and Sturgeon were among the more than ordinary objects of interest in the Society's museum.

A time arrived when the model room ceased to be an object of general interest; the models were neglected and became dilapidated, and the museum was eventually done away with; but at the time of the actual dispersal, a good deal of the more interesting apparatus, including, it is believed, that of Messrs. Marsh and Sturgeon, had disappeared, no one knew how.

King's College possesses a collection of Wheatstone's apparatus, and seeing the very close connection which existed between that college and Wheatstone, it is understandable that they should attach considerable value to apparatus which is in a sense classical, but to the public generally this apparatus of Wheatstone is quite inaccessible.

An electrical museum of any real value would take up a good deal of room, and would also involve the Society in a considerable expenditure; the opening of such a museum would no doubt be inaugurated with a flourish of trumpets, and attract attention for a time; after which it would become more or less neglected, and sooner or later it would probably share the fate of the Society of Arts Model Room.

Moreover, there is already at South Kensington a museum of engineering, electrical, and other scientific apparatus, collected together, where they can be better seen and more conveniently studied than would be possible at the Electrical Institute, and which has the additional advantage of being accessible to everybody.

We had the good fortune a few months ago of meeting in the museum at Sonth Kensington an American stranger studying the scientific apparatus, and we were pleased to hear him say that there was no city in the world comparable with London for obtaining knowledge, and that there was no collection of scientific apparatus in any other capital such as that to be seen at South Kensington. This American was a young engineer on a visit to Europe to pick up information; he said he had already spent some days going over the museum, and he intended spending a few more days. We offered to point out to him the chief electrical apparatus of interest, an offer of which he was glad to take advantage.

The more concentrated, the more accessible is a collection of apparatus for the purposes of study, especially to strangers, and there is also a certain advantage in gathering together mechanical, electrical and other scientific apparatus so as to be able to compare them one with the other, and to study them together; we should therefore be sorry to see any of the apparatus now at South Kensington removed to such a museum as it is proposed to create in connection with the Institute of Electrical Engineers.

THE ELECTRO-DEPOSITION OF COPPER.

ON another page we briefly give an account of a visit to the works of the Elmore Patent Copper-Depositing Company. The result of our inspection of the plant and *modus operandi* of the process in no way alters the opinions we have previously expressed; indeed, we feel that our position is considerably strengthened. The plant which is used to deposit five tons of copper per week necessitates at least, when considering the loss in the transformation of mechanical into electrical energy, 75 horse-power developed during the 168 working hours. The cost of this, with the fuel and labour for melting Chili bars to form "shot copper" as anodes, the labour in the bath rooms, machine room, &c., and without taking into consideration depreciation of plant, office expenses, rent of factory, management, and all other incidental expenses, would certainly be at least double Dr. Hopkinson's estimate, an opinion we have previously given, and of which we now feel certain. It would appear, however, on the face of it, that even if the working expenses were greater than we anticipate, the profits of the company are not materially affected, as the lowest priced articles are said to be sold at 6d. per lb. above the price paid for raw copper.

This would mean a perfect golden harvest to the Elmore Company, if it were not for certain drawbacks which are naturally not confided to the public. It was admitted that certain tubes ordered had not come up to the specification degree of hardness in manufacture, and in consequence were relegated to "stock." It would be interesting to know what proportion such tubes which might be termed "wasters," bear to those which pass muster, and also whether when the former are "stocked," they can be considered of any real value? The production of Elmore copper being now confined to tubes only, which are admittedly first-class specimens of manufacture when the deposit meets requirements, the fortunes of the company depend not only upon the high price to be obtained for such articles, but also upon the extent of their sales, which may be comparatively limited. Indeed, up to the present we can obtain no information as to any real business being done beyond vague promises on the part of certain copper merchants to take the Elmore productions if they can be supplied.

So far as the Wire Company is concerned, we do not conceal our belief that its foundation is very unsatisfactory, and that in this branch of electrical industry at least there will be found competitors offering, at ordinary market prices, just as good material as Elmore copper. Assuming that this be so it may be pointed out that the whole of the capital transferred by the Wire Company to the vendor company must now be considered, so far as the Wire Company is concerned, as absolutely thrown away. The promoters are thoroughly well aware that the Mouchel copper compares favourably with that of Elmore, and there is now in Liverpool a copper refinery delivering 60 tons of copper per week to wire drawers with a guaranteed conductivity of 100 per cent., Matthiessen's standard.

Altogether, visitors must have felt somewhat disappointed at being shown half finished buildings which are eventually intended to contain copper depositing plant and wire-drawing machinery, treated to descriptions, illustrated by a broken-down old lathe, of machines for wire-producing which do not yet exist, and still more so at being left entirely in the dark as to the legitimate amount of business which the company is doing, or is supposed to be carrying on. The largest contingent of Press representatives were from our financial contemporaries, and as there are rumours that an American company is likely to be brought out within the next few weeks we fear that it will be generally conceded that the *raison d'être* of the publicity now given to the Elmore works, a publicity too long delayed, will be found to lie in new financial operations rather than in developing the electro deposition of copper as a *bonâ fide* business.

Our inspection of the works intensifies our feelings, almost amounting to disgust, that the patents for the process should have changed hands for fabulous sums of public money; it throws into even stronger relief the absurdity of M. Secrétan's report and the indiscretion of the directors in acting upon it. Those at the head of the business will be singularly ill-advised if they attempt any further financial operations. There is quite sufficient responsibility on their shoulders, and if they only recognise the fact that the responsibility will in process of time, whether more or less delayed, be brought home to them, they will know that their true friends are those who advise them to face the facts at once, and not to proceed on lines prompted by sanguine hopes and a putting off of the evil day.

Incandescence Lamps.

OUR contemporary, *Engineering*, in a recent issue, deals at some length with the subject of the deterioration of incandescence lamps, the results of tests described by Mr. W. H. Pierce in his paper before the American Institute of Electrical Engineering being analysed. It is somewhat surprising that the subject has not been dealt with to any extent by anyone on this side of the Atlantic, so we are obliged to accept the results of the American investigations (which appear to be very thorough) as representing the general state of affairs. There seems no reason, however, to suppose that the manufacture of incandescence lamps in this country has resulted in any better specimens being produced, as regards durability, than elsewhere. One fact does not yet appear to have been established, and that is, whether the durability of an incandescence lamp is greater or less with alternating than with continuous currents. Professor Ayrton has proved that the efficiency is practically the same for the two cases, but durability has not been dealt with. There appears to be two aspects from which this question may theoretically be regarded, viz., does the alternating current by its rapid alternations perpetually rack, as it were, the carbon filament, or does one alternation undo the disintegrating strain of the other? As far as one can see, there appears but little hope that any substance can be produced which can resist the effect of the high temperature to which it is necessary to bring the filament in order to produce a reasonable efficiency, and the question arises, whether, in view of this fact, it would not be better to devise some satisfactory method of cleansing the inside of the glass globes, and possibly of providing spare filaments to be used in turn as the one in use deteriorates beyond a certain stage. The results of the American experiments dealt with by our contemporary seem conclusively to prove that the average efficiency of their lamps does not exceed 5 watts per candle, and that all statements to the contrary must be accepted with great suspicion, and can only be correct as regards a very short initial period; moreover, it appears that a lamp starting with a high efficiency is not necessarily more or less efficient than one starting with a low efficiency. Probably the real solution of the whole question will be that of producing the lamps at such a low price that a short life at a high efficiency will be the order of the day, although English experience does not confirm the suggestion; this will either necessitate the abandonment of the use of platinum or the more economical use of it. Incandescence lamps at a few pence each would settle the whole question, hopeless as such a consummation seems at present.

PLANT EFFICIENCY WITH OPEN AND CLOSED CIRCUIT TRANSFORMERS.

By WILLIAM STANLEY, Jun.*

SEVERAL contributions on the relative merits of the closed and open circuit transformers for the distribution of electrical energy, have lately appeared in *The Electrical Engineer*, New York. In various letters, Mr. Swinburne has maintained that the open circuit transformer is more efficient than is its opponent of the closed magnetic circuit type, and that consequently, American engineers were applying and advocating apparatus lacking maximum efficiency.

When, in 1885, I constructed the first closed transformer, and adapted it for commercial lighting, I had in mind the very differences which are now being discussed, and at the same time there seemed to me to exist certain objections to open circuit transformers which still appear to me to be of such magnitude that I believe, in America at least, the open circuit transformer is at a disadvantage. Of these objections I have seen no mention; they are briefly as follows:—

In the open circuit transformer of the Rhumkorff, the Gaulard and Gibbs, or the Hedgehog type, high efficiency is due to the fact that the fluid (or air) portion of the magnetic circuit causes the current phase to lag behind the E.M.F. more than in the closed magnetic type, and in a well-constructed transformer of the open circuit type this lag is nearly 90° at no load, that is, when the secondary circuit is open. Now in these transformers the value of the primary current varies comparatively little with the load derived from the secondary circuit, and when such a transformer is gradually loaded, the primary current will remain, roughly speaking, constant, while the lag of the current behind its E.M.F. will diminish; the phases of current and E.M.F. more nearly coinciding as the energy taken from the transformer is increased.

In the closed circuit type of transformer, however, the *value of the primary current in ampères* is very nearly in direct proportion to the load upon the secondary circuit. Thus while the primary current in the open circuit type remains, roughly speaking, constant, possibly varying 10 to 20 per cent., the primary current in the closed type is proportional to the load.

Let us examine briefly the station requirements for the two contrasted types. With the open circuit type $\frac{8}{10}$ths of the station plant, that is, $\frac{8}{10}$ths of all the engines and dynamos, must run continual to supply the primary currents, for the ampère value of these currents is about constant; while with the closed circuit type of transformer, the engines and dynamos in service vary in proportion to the number of lamps burning. Thus, in a station having 10 dynamos and engines of equal size, in many places one dynamo and engine will easily supply all the energy necessary during 12 or 14 hours out of the 24, when the closed circuit or American type of transformer is used; while, with the open circuit type advocated by Mr. Swinburne, at least eight of such engines or dynamos would be required to do the same work. The question arises, therefore, Which system uses the least fuel, and costs the least?

For the sake of simplicity, we will allow Mr. Swinburne's transformer to have 100 per cent. efficiency. We will also allow the closed circuit transformer an efficiency of 95 per cent., which can be proven to be commercial practice in well-designed transformers. Placing the engine losses at 10 per cent., and neglecting the losses in the main, we find that with the open circuit type the loss is eight times as much as with the closed type, neglecting transformer losses; or 7·6 times, including these losses. In short, it requires about seven to seven-and-a-half times as much coal to maintain current for open circuit as for the closed circuit type, because, during the idle period of the day, approximately seven to eight times as many dynamos and engines have to be run, and the principal losses occur in these elements instead of in the transformers. During the remainder of the day, about one-half of the time, that is a quarter of a complete day, the efficiencies of the systems employing these two types would be equal; and during the remaining quarter of the day the efficiency of the open type would be 5 per cent. greater.

I therefore dispute Mr. Swinburne's statement that an open circuit transformer is as efficient an element of a system of distribution as its American brother. With higher frequency the open circuit transformer will make a better showing, and probably will be used, providing we can arrange means to obviate the extra losses.

By the way, why use the words converter or transformer? Would not Cyclotrope or Ergotrope, meaning that which transfers from a circuit, and that which transfers energy, be more appropriate?

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* *Canadian Electrical News.*

PROGRESS OF THE ELECTRICAL INDUSTRIES.

(*Continued from page* 107.)

JOHNSON AND PHILLIPS.

A large number of both continuous current and alternating dynamos have been built and sold. Amongst the former were machines for the Duke of Northumberland, K.T.; the General Post Office, Birmingham; the National Museum and Libraries, Dublin (coupled direct to Willans's engines); Madame Tussaud's exhibition, and many others, for important installations and for ship lighting. We may mention complete sets for the Hong Kong central station, a machine for the extension of the Keswick central station, and several others for the Continent. Eleven sets of the Kapp central station continuous current dynamos are now being built for the Vestry of St. Pancras, the first local authority in London that will undertake the supply of electricity themselves. The battery department has been fully occupied in making complete sets of accumulators. The vulcanised rubber shops have also been full of work, making cables for the electric light and transmission of power. The business in the Brockie-Pell arc lamp department has been extremely satisfactory, and shows a very large increase over 1889. Amongst the numerous establishments where this lamp has been introduced during the year may be mentioned the following: General Post Office, London; General Post Office, Birmingham; the Royal Mint, London; the Government Quays, Sydney, N.S.W.; the National Museum and Libraries, Dublin; "The Empire," and many other theatres; Madame Tussauds's exhibition; the Gaiety Restaurant; Spiers and Pond's new stores, Water Lane, E.C.; Winchester House, Old Broad Street, E.C.; Sir Arthur Guinness, Son & Co., Limited, Dublin, &c. A large number of these lamps have also been supplied for the lighting of railway stations belonging to the Great Northern, Great Eastern, Lancashire and Yorkshire, and other companies, whilst a few alternating lamps have been placed in the streets of Newcastle-on-Tyne for public lighting. The arrangements are now on the point of completion for lighting all the principal streets and quays in Hong Kong with double carbon 32-hour lamps on the continuous current series system. Several additional buildings have been erected by this firm during the year to meet the general growth of the business.

MANCHESTER EDISON-SWAN COMPANY.

This company have experienced a considerable increase in their business during 1890—33,469 incandescent lamps having been supplied by them for the Lancashire district.

In the commencement of the year they found it necessary to take additional premises in Little John Street, Manchester, on account of the increase in the manufacturing branch of their business. This, however, now proves to be inadequate, and it has been decided to move their works further out of the City, where a well-appointed and commodious factory will be built.

In the installation department a large quantity of work has been carried out during the past year.

Several important installations are at present in progress, amongst which may be mentioned 1,500 lights for the Wholesale Co-operative Society, at Leicester; the lighting of the premises of the Derby Co-operative Society; the Restaurant of Thomas Parker and Sons, Manchester; S. Hazzopulo's café, Brown Street, Manchester; the warehouse of Messrs. Frautenburg & Co., Greengate, Salford; the offices of the Manchester Ship Canal Company; the premises of J. Nelson, Esq., Bury; extension of the Bolton Co-operative Society installation; and the mansions of Lord Howard, of Glossop; Jos. Cliff, Esq., Brigg; J. C. Waterhouse, Esq., Prestbury; Mrs. Wood, Glossop; and Jos. Wood, Esq., Chorley.

THE NEWCASTLE-UPON-TYNE ELECTRIC LIGHT COMPANY.

Work is increasing steadily. The company have sufficient confidence in electric lighting plant to arrange to supply power at an exceedingly low price. Of course, it must be remembered that gas is cheap in Newcastle, as coal is cheap; but cheap coal does not reduce the price of electric power in anything like the proportion it reduces the cost of gas. Two Robey engines are used, with trip gear of the Corliss type. Mordey dynamos and Mordey and other transformers are in use. The leads are chiefly, if not wholly, underground. Mr. R. C. Jackson is engineer, and he has the benefit of Mr. A. W. Heaviside's extensive experience of underground wirework.

THE SHEFFIELD TELEPHONE COMPANY

have two Mordey alternators in use and Mordey transformers. One dynamo is driven by a Brush engine. The lighting here is of a specially remunerative nature, as it has been mostly taken by shops, so that the dynamos need not run during the day, and full load comes on early in the evening.

SOCIÉTÉ GÉNÉRALE DES TÉLÉPHONES.

The expiration of the Bell patent and the near approach of the time when the present telephone monopoly will come to an end, has had the effect of turning the eyes of Continental manufacturers to this country, and several have recently established branch businesses in London. The Société Générale des Téléphones, which has opened an agency at No. 29, Ludgate Hill, under the management of Mr. G. A. Nussbaum, is well known as owning the largest manufactory of telephones in Europe. Visitors to the Edinburgh Exhibition will call to mind the splendid show made by the society in the French Electrical Section, where its exhibits occupied the whole of one side of the annexe. At the Paris Exhibition of 1889 its exhibits were still more numerous and interesting, and were located in a special pavilion. Some idea of the extent of the society's operations may be formed from the following particulars. It has, at Grenelle, works for the manufacture of telephonic, telegraphic and similar instruments, employing over 400 men. Its manufactory at Bezons for electric conductors of all kinds, gutta-percha and ebonite goods, employs about 250 hands, and very large works have recently been erected at Calais in which to manufacture submarine cables. The society owns the Ader and the Berthon patents, under which have been made most of the instruments in use in France. The telephone systems of Paris and of many of the principal towns have been installed and are still conducted by the society. Special instruments have been extensively manufactured for the French army and navy, those for use on board ship being utilised for the transmission of orders from the block-house to the engines, to the wheel, to the torpedo posts, ordnance, &c. The metal parts are of extra strength and coated with varnish to prevent oxidation. In order to reduce to a minimum the number of contacts, and to avoid using any kind of switch, two distinct circuits are employed; the one serves for conversation, the other for the call-bells. A single battery serves the call-bells of all the stations on board a ship. In this manner only two cells are necessary at each station for working the microphone. The stations are connected by means of cables in India-rubber insulation, with copper bracing; for each direction one cable with five conductors is required. The telephonic apparatus includes a microphone (Berthon) and a receiver (Ader) connected by a handle; a second receiver being used where the surrounding noise would interfere with properly hearing with one ear. Experiments on board the *Devastation* have proved that with this apparatus a conversation was not interrupted between the block house and the central fort even during the firing of the large cannon. The microphone is so constructed that dampness has no influence upon it, and the same with the receiver, the coils of which are let into a bituminous block. On board the *Devastation* an apparatus has been used after having been immersed in a pail of sea water. Instruments of this description have been fitted by the society on all the steampackets of the General Transatlantic Company (Havre-New York line), the ironclads *Devastation*, *Redoutable*, *Amiral Duperré*, *Courbet*, *Amiral Baudin*, the cruiser *Cecille*, the cruiser torpedo-boat *Sfax*, the Spanish ironclad *Pelayo*, and others.

SYDNEY F. WALKER AND COMPANY

cannot show a very large record of new work during the past year, not so large as they would like, owing to the keen competition which has prevailed. There has been plenty of work, but plenty of people to do it. During the summer this firm laid down a 400-light plant for a large coal and iron firm in Lancashire. As rather a new departure was made in this case the details may be interesting. The installation consists of two complete and independent plants, each capable of furnishing 200 lamps or their equivalent. Separate engines and dynamos are used, not connected in any way; and the whole is so arranged by means of specially designed switches, on Mr. Walker's bent spring principle, that either engine and dynamo can be switched on to any part of the work at will.

THE WOKING ELECTRIC LIGHT COMPANY

opened their station on the 1st of November. Kingdon dynamos are used, and hedgehog transformers. Some of the leads pass under a river, and the Fowler-Waring cable stands this strain perfectly.

A NEW BICHROMATE CELL.

No practical man needs to be told that a bichromate battery possesses many disadvantages along with its advantages. Yet it is very useful for many purposes and it has doubtless often occurred to electricians that if only such a battery could be made, yielding a powerful current for a lengthened period of time, it would, to use the well-worn phrase, "supply a long-felt want."

A recent number of *Dingler's Polytechnisches Journal* contains an account of a new modification of the bichromate cell which has been devised by P. Gendron.

In the "Gendron" cell either potassium bichromate or sodium bichromate is used for making the depolarising liquid. Other special features are the following: The area of the electrodes is large in proportion to the capacity of the cell. The electrodes are placed parallel to each other and as closely together as possible, thus minimising the internal resistance. The zinc plates are readily exchanged, and this can be done without the usual necessity of interrupting the current. The fluid is kept at a constant level whilst the exhausted liquor is removed from the lower part of the cell by means of an automatic arrangement of valves.

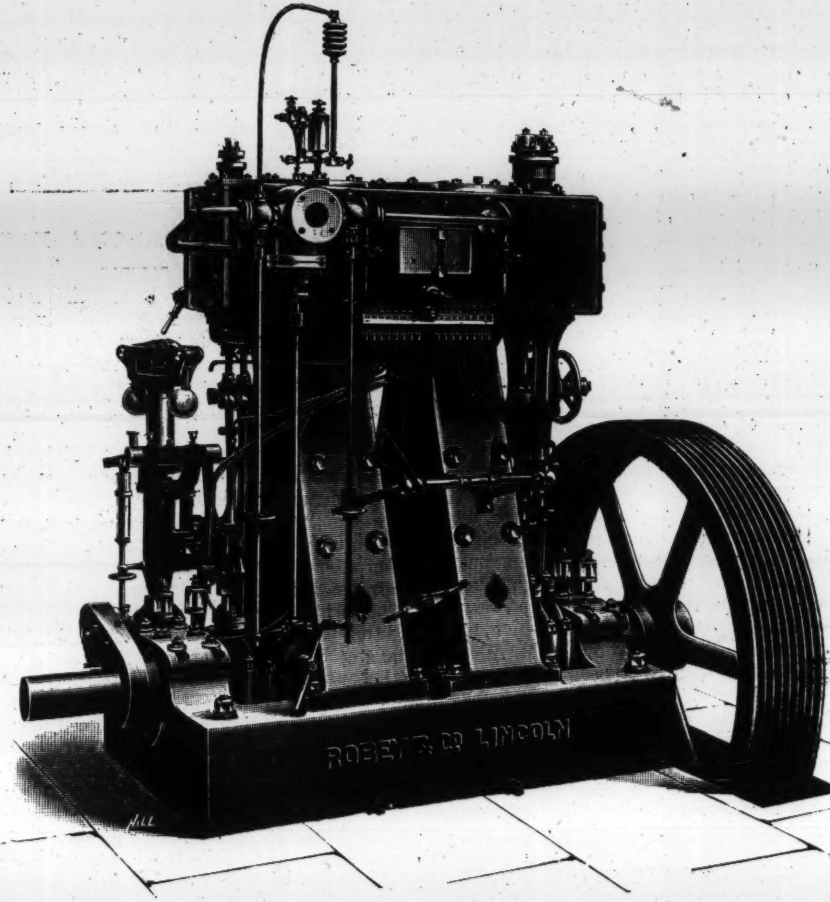
Full details and drawings are given in the original paper of this interesting modification of the bichromate cell.

It is stated that this kind of battery will give a very powerful current of electricity for a very much longer time than is given by the ordinary arrangements of bichromate cell.

ROBEY COMPOUND ELECTRIC LIGHTING ENGINES.

WE give an illustration of an engine made by Robey & Co., of Lincoln, for the Newcastle-on-Tyne Electric Supply Company, to drive a 37½ unit Mordey Victoria alternator, which developes 70 to 75 horse-power, for electric light installations. It has a high-pressure cylinder 11 inches diameter, low-pressure ditto 18 inches diameter by 12 inches stroke, and makes 200 revolutions per minute, though it can be worked up to 250 revolutions. The crank-shaft is 6 inches diameter, and has three bearings, with a total length of 32 inches. All the working parts have very large wearing surfaces, and the engine throughout is of most massive build. Every part being carefully balanced, and the right provision being made in the set of the valves, the engine can be run at the high speed of 250 revolutions per minute with ease and safety, and there is a total absence of vibration or shock. All the working parts are well lubricated from a central oil box, which is fitted with an indicating contents gauge. Each separate point to be oiled has an independent adjustment, with a visible drop feed.

The engine is governed automatically by link expansion gear, controlled by a powerful Richardson governor, and not more than 2 per cent. variation in the number of revolutions is made between all load on and the engine running light, while with ordinary changes of load the variation is imperceptible. The governor is driven by gearing direct from the shaft through machine cut wheels, which are enclosed in a casing. The weight of valve rods is compensated by means of steam plungers, so that the whole motion is in complete balance. The governor is also fitted with an extra adjustment, by means of which the speed can be varied while the engine is running, and set at any required number of revolutions. The large ends of the connecting rods are fitted with centrifugal oilers, which are continuously supplied with lubricant. The crank and connecting rods being protected by the main standard, any splashing or waste of lubricant is avoided, and all drips are collected in suitable wells in the baseplate, from which all the oil can be removed by passages and cocks arranged for the purpose. The lower part of the columns on the front side is arranged to be removed when it is required to examine the crank pin, or to take out the crank, and this can be quickly and easily done without disturbing any other part of the engine. All the levers and handles are brought conveniently together in front of engine, so that the starting valve, intermediate receiver, drain cocks, and governor adjustment can all be attended to from one position. The engine may be used to drive a dynamo direct, or with belts or ropes.



The Newcastle Electric Supply Company has, in its Newcastle station, three other coupled compound engines of Messrs. Robey & Co.'s make, each of 200 horse-power, which are used during the evening. The smaller one, which is for varying in power from 40 to 200 indicated horse-power, is used for day lighting, and to work during the day and night in conjunction with one or more of the larger engines.

COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM A CORRESPONDENT.]

IN the session of the Vienna Common Council, on January 16th, the draft agreement with the International Compressed Air and Electric Company, was considered, and with slight modfications, accepted. This result could not surprise anyone, as the Vienna Common Council, when it had once accepted the position of free competition, and had already conceded the erection of three electrical works in the city, could not be expected to refuse a concession to the company just mentioned. It is strange, however, that Herr Josef Kareis, editor of the Vienna *Electrotechnische Zeitschrift*, in his quality as a member of the Common Council, should plead the cause of the Popp system, in such a manner as took place during the discussion. A member of the Common Council proposed that the duration of the concession should be limited to 40 years, and that after the lapse of 15 years the agreement could be broken off on giving a one year's notice. Herr Kareis replied that in his convictiou, after about 15 to 20 years, the City, would doubtless take all such undertakings into its own hands. If the question is raised why this could not be done at once, the reason is that daily inventions and improvements are being made which would then be effected at the cost of the community. All the present arrangements were of a primitive character. On the part of the opposition an intention had been expressed of effecting, by means of this undertaking, a competition with the other electric companies, and it should therefore not be placed on a less favourable footing than its rivals, and as they are in possession of agreements for 50 years, a term of 45 years might be suitable for the Popp Company. The paragraph in question (2) was in fact accepted in accordance with the proposal of the referee.

Sec. 9 of the agreement fixes the rent for the use of the streets at one kreutzer per metre of cable. In case of cables or pipes running parallel, the rent is payable only for the cable. Besides, the Company has to pay the City a 3 per cent. tax on its gross receipts.

Sec. 25 of the draft agreement had decided that the company should give security for 10,000 florins. It was proposed that this guarantee should be increased to 50,000 florins, and this proposal was carried.

The arrangement in sec. 23 must further be noticed. It binds the company to obtain its materials, machinery and other requisites for erecting and working its installations in Austria, with special reference to Vienna, provided that such requisites can be obtained in Austria. The exceptional supply of such requisites from abroad depends on the consent of the Viennese community. In erecting and working the installations, native labour and skill are to have the preference.

In the Bohemian watering-place, Teplitz, the gas company seems to have reached its object, so that the projected erection of electrical works by the town is frustrated or, at least, deferred. By the threat to contest the right of the town to erect works, the company has succeeded in introducing negotiations, which were brought to a definite conclusion at the last meeting of the lighting commission.

At this meeting the points were decided according to which the town agrees to enter upon an arrangement with the Teplitz-Schoenau Gas Company, and it depends exclusively on the latter body whether this arrangement is carried out. The following are the chief points of the convention :—

1. The town of Teplitz agrees to uphold its agreement with the Teplitz-Schoenau Gas Company for five years. 2. The town concedes to the company the right of supplying gas to private consumers for driving motors, at any price which may be agreed upon, even if it is lower than the figure which the town pays. 3. The town is entitled after the lapse of these five years to take the lighting of the streets into its own hands by means of electricity. 4. The town after the expiry of two more years, *i.e.*, after the lapse of seven years, to supply electric current to private consumers, whether as a source of power or of light. 5. The town is at liberty to commence the erection of its electric central station during the five years without being open to any objection on the part of the gas company. 6. The gas company during the five years is to charge for a street lamp burning for 1,250 hours, 17 florins, instead of 20 florins as previously agreed upon.

If this arrangement is accepted, after the lapse of the five years we shall have the anomaly that the town will be entitled to erect electric works and to light the streets electrically, whilst private consumers will still be compelled, for two years longer, to put up with gas.

At the Imperial Palace at Vienna, the electric lighting was used for the first time on the 17th of January, on occasion of a public reception at court. This new and brilliant illumination displayed the splendid decoration of the halls for the first time in their full beauty. The glow lamps of the great lustres produced a really fairy-like effect.

The ministry, it is reported, intends to refuse the concession for laying down and working an electric railway between Budapest and Vienna, on the ground that the projected line would enter into direct and strong competition with the Royal Hungarian State lines.

The daily papers, which have just appeared, reproduce the conditions which are said to have been agreed upon between Popp and the Mayor of Budapest for the concession of a compressed air installation at Budapest.

On the basis of this arrangement, the Popp Company has put forward the following determinations as the ground of further negotiations.

A concession for 40 years is demanded ; if in the first 10 years 15 kilometres of pipes have been laid down no new concession may be granted, but it may afterwards to any one. For the use of the ground Popp is to pay yearly 10 florins per kilometre of piping, and binds himself to allow the municipality daily, for public use, 100 metres of compressed air. The prices for private consumers are not fixed, but the price per cubic metre is never to exceed $\frac{4}{5}$ths kreutzer. Agreements between Popp and private consumers are to be submitted for approval to the authorities. Coal and oil are to be exempt from tolls. Of the net profits of the undertaking 15 per cent. falls to the share of the municipality. After 40 years the municipality takes over the entire installation at a valuation. If the town already has obtained 15 per cent. of the net profit it can obtain the installation after 20 years for a sum which would give 6 per cent. interest on the average returns of the last five years. The pipes must be laid within two years from the signature of the agreement. If the electric light should be introduced, Popp claims no priority for lighting on his scheme.

A NEW ELECTRIC LOG.

A new form of electric log has recently been introduced to the shipping world which, as it possesses many novel points in its method of working, &c., is well deserving of a full description.

Practically, in all apparatus used for measuring the speed of a vessel, a small "fan" or "propeller" is drawn through the water either astern or abeam of the ship, and is, in consequence, caused to rotate with a speed which is intended to be proportional to that of the vessel.

There are two types of mechanical logs based upon this principle. In the first the rotating fan is directly geared to a clockwork train which counts the revolutions and indicates in knots, on a series of two or three dials, the total distance run, the whole apparatus being towed through the water at the end of 30 or 40 fathoms of line. With this arrangement, whenever it is desired to ascertain the distance run, the whole length of line must be hauled in, and this is no easy task with a rapidly steaming vessel, the strain being very great. Another disadvantage is that whilst an observation is being made the log is idle and the distance run is unrecorded. Again, it occasionally happens, that, whilst being towed, seaweed or floating refuse fouls the log, rendering the indications useless, and this cannot be ascertained until the log is hauled on board. In the second form of log the fan alone is drawn through the water, being rigidly attached to a long length of line as before ; the fan in this case rotates the whole line, the ship end of which is connected to the counting apparatus fixed upon the stern rail of the vessel. This device requires a table of corrections, for in consequence of the excessive amount of work required to be done by the "fan" in rotating so long a length of line, a portion of which is continually in the water, the speed of rotation is not nearly proportional to that of the ship ; in fact, at a slow speed it may be 20 or 25 per cent. too low, therefore, to be exact, *it is first necessary to know the speed of the ship before the right correction can be applied.*

The very obvious advantage of combining the accuracy of the first type with much more than the convenience of the latter, has induced several attempts to construct an electrical log by causing the rotating fan to periodically "make" and "break" contact and thereby, by means of a conducting tow line and a battery cell, to work an electro-magnetic counter placed in any position on board ship. This idea, so captivating and simple in theory, has repeatedly been proved to be impossible in practice, and that for the following reasons :—

In the first place the tow line, which is alternately wet and dry, is subjected to a great amount of rough handling, and is kept in a continuous state of movement, due to the action of the waves and the motion of the ship, so that in a very short time the insulation becomes faulty.

Secondly, the attachment between the end of the log line and the log must be perfectly water-tight and insulated, and, lastly, there must be a contact chamber kept perfectly free from moisture, although so arranged that the contact maker enclosed therein is worked by the movement of the fan, for any loss of insulation in the whole system would short-circuit the battery through the indicator, and so lead to failure.

That this necessity of having perfect insulation has so often proved fatal can be clearly understood, when we consider that with modern ships the log is often towed at a speed of 20 knots per hour, with the result that the salt water is forced through apparently the most perfect joints.

Again, a ship may have to stop before a log can be hauled in, and consequently the log sinks to the full length of its line—say, 30 fathoms—which means a pressure of 80 lbs. upon the square inch—enough to ruin any so-called water-tight chamber.

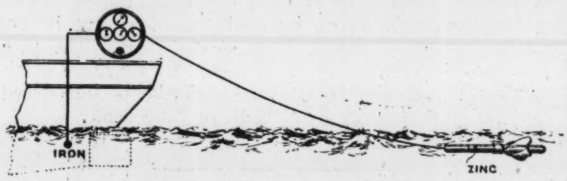


FIG. 1.

Mr. W. P. Granville, while accepting the principle of the rotating fan, has devised a novel electrical method of recording the number of revolutions, and by his device insulation is rendered unnecessary.

By this system a battery cell is dispensed with, for the hull of the ship forms one pole of a battery, a thick tube of zinc in the log itself the other pole, and the sea water the exciting fluid; thus there is formed a zinc-iron couple in salt water having an approximate electromotive force of ·7 volt, and an internal resistance of about 1 ohm. It might appear, at first sight, that the wide separation of the two component parts of the battery would cause a large increase in the "internal resistance;" but this is not so, for experiment proves that after the first few inches, the distance between the two electrodes is practically immaterial, so far as the resistance of the salt water is concerned.

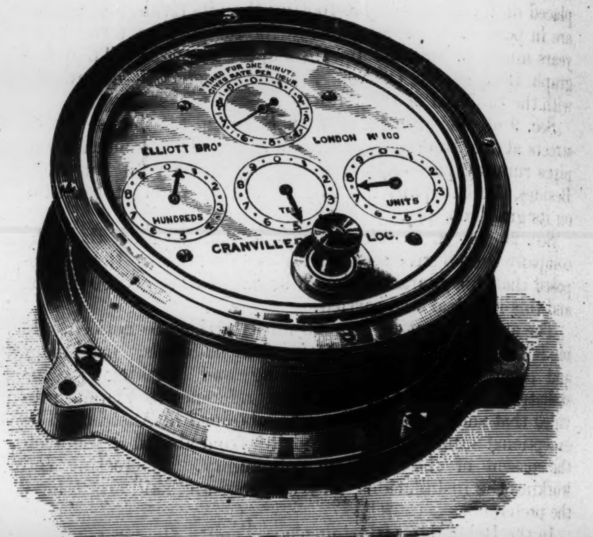


FIG. 2.—APPROXIMATELY ONE-HALF FULL SIZE.

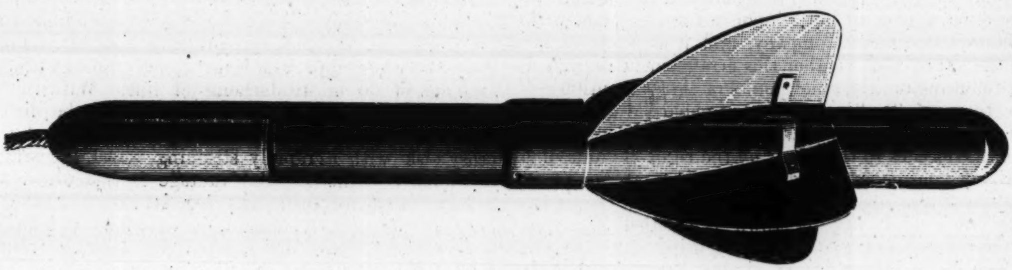


FIG. 3.—APPROXIMATELY ONE-FOURTH FULL SIZE.

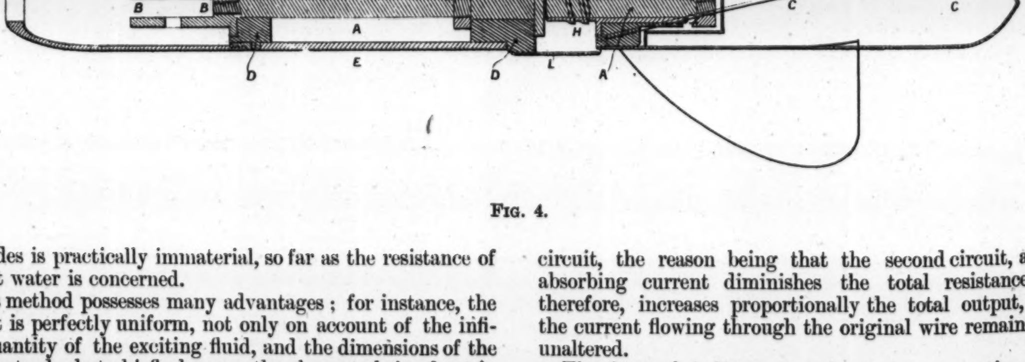


FIG. 4.

This method possesses many advantages; for instance, the current is perfectly uniform, not only on account of the infinite quantity of the exciting fluid, and the dimensions of the iron electrode, but chiefly because the elements being kept in rapid motion, no polarisation can occur. The most important benefit gained is, however, that it enables insulation from the sea water to be dispensed with (in an actual experiment the log was towed with 100 feet of bare pianoforte wire and the indicator worked perfectly). To understand this we have only to consider that, under these conditions, the effect of using an uninsulated tow-line is simply to provide an additional, or shunt, circuit direct to the sea. If the battery or conductor had high resistance this would be fatal, but, it is well known, that with a battery of low internal resistance the current in a wire connecting the two terminals is but little affected by the addition of a second wire or shunt circuit, the reason being that the second circuit, although absorbing current diminishes the total resistance; and, therefore, increases proportionally the total output, so that the current flowing through the original wire remains almost unaltered.

The log and indicator are shown in perspective in figs.

2 and 3, whilst fig. 4 is a section of the log showing its construction. A centre rod of gun metal, A, A, carries at one end the fork piece, B, B, which is slotted to receive the thimble on end of log line, as shown in detail in fig. 4. The other end of the rod forms the spindle for the rotating head, C, C, provided with four blades set at the required angle and with ball bearing to receive the end thrust.

The centre rod also carries the two vulcanite collars, D and D, between which the zinc tube, E, E, is clamped, a gun metal stud surrounded with a vulcanite bush is driven tightly into one end of the zinc, and this stud is in metallic connection with the contact spring, F, which normally rests on the vulcanite pin, G.

The revolving head carries at its base the worm, H, gearing into the worm wheel, J, which makes one revolution for every six of the revolving head, the spindle of the worm wheel projects, and is half filed away to form the cam, K, so as to rub against the contact spring once every revolution of the worm wheel, thus putting the zinc into contact with the centre rod, and so through the fork piece and brass thimble to the conducting tow line; a short brass tube, L, surrounds the working parts, preventing the entrance of sea weed, and yet, being readily removed, it permits the working parts to be freely accessible, as shown in fig. 5.

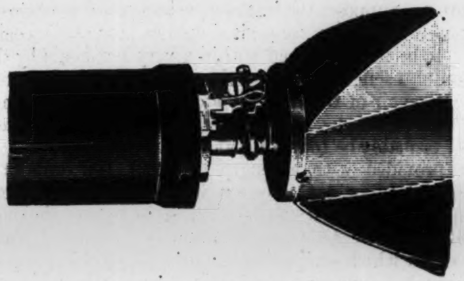


FIG. 5.

The log line is composed of five copper wires spirally twisted round a strong core of hemp; this arrangement prevents any strain upon the conductors and gives flexibility, and the whole is then braided with strong twine. The five wires are "bunched" at each end, so that if four out of the five were broken the remaining one would sufficiently keep up continuity. The sea end of the line is fastened round a brass thimble and the five wires soldered thereto.

The indicator consists of a simple train of wheels driven by a spring and provided with an escapement actuated by the electro-magnet, so that one tooth of the escape wheel is released whenever contact with the zinc is made. The main spring requires winding every 500 knots travelled, or, say, daily. As shown in the illustration, the indicator is provided with a fourth dial, the hand of which makes six revolutions for every knot travelled, so that each of the 10 divisions represents $\frac{1}{60}$th of a knot, and consequently when timed for one minute it shows the rate per hour, because each division bears the same proportion to a knot that a minute does to an hour.

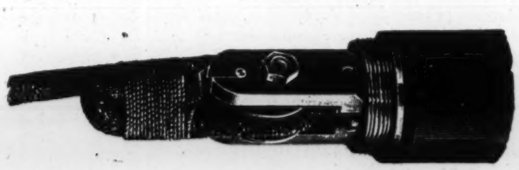


FIG. 6.

The indicator is intended to be permanently fixed in any position required, for instance, on the bridge or in the chart room, or, if necessary, one may be placed in each position, for the same log will readily work two or three indicators, one terminal is permanently connected to any part of the metal framework of the ship, for instance, to a bolt in a bulkhead, &c., and the remaining terminal is connected either direct or by means of a leading wire, to the ship end of the conducting tow line.

It will be seen from fig. 6 that the log line is fastened to the log by a simple bolt and nuts, thus forming at once mechanical and electrical connection, so that the log can be easily detached at will—indeed, the whole apparatus is designed so as to call for no skilled attention or extraordinary care.

The log has successfully undergone a series of Admiralty trials at Portsmouth at all speeds up to 20 knots per hour, being tried from torpedo boats and also from H.M.S. *Barham*, it has deen proved to work with accuracy and certainty. When first tried from a newly-built torpedo boat no current was set up, the cause was at once discovered and as soon remedied, the fact being that most of these boats are built of *galvanised* steel, which practically means that instead of having a zinc-iron or zinc-steel couple, both electrodes were of zinc and consequently no current was generated. The cure proved most successful, for it perfectly sufficed to tow a short length of bare copper wire and to connect it to the indicator instead of using the ship's side. As a matter of fact it was found that with older torpedo boats although of galvanised steel yet ample current is generated to work the indicator no doubt due to the fact that the thin coating of zinc becomes to a large extent dissolved. During one trial the following were the means of several to and fro runs over the measured mile :—

At the speed of 6·8 knots per hour 1·012 knot registered.
" " 10·1 " " 1·008 " "
" " 13·6 " " 1·005 " "

We understand that the apparatus is being manufactured by Messrs. Elliott Brothers of St. Martin's Lane.

STORMS AND TELEGRAMS.

By W. SLINGO AND A. BROOKER.

(*Continued from page* 101).

IT would appear from the considerations discussed in the previous article that an ideal telegraph line would be one in which the poles are of ample size and frequency, deeply set, provided liberally with stays, and maintained in the highest state of efficiency. In fact, no effort should be spared to enable the poles to withstand the most sudden and the heaviest strains likely to be brought to bear upon them, while the wires should be so proportioned that they will give way just before the poles during storms of phenomenal violence. This proportion, together with high electrical conductivity can be more easily obtained by using copper instead of iron wire, and then, when the crash does take place, only light and portable materials and appliances have to be transported and the work of renewal can thus be speedily effected.

In addition to the points already mentioned there are others, chiefly electrical and of considerable importance, which tend to show that copper is preferable to iron for an overhead telegraph system.

Not only is the specific resistance of copper low, but it has the great advantage that it permits of a much more rapid variation or alternation of the current than does iron, and hence it is invaluable for use on circuits which it is desired to work at a very high speed, or along which very rapid pulsations of current are required to be transmitted. It must also be remembered that in some localities, for instance in large towns, or in the neighbourhood of chemical works, copper, in consequence of its feeble affinity for the majority of atmospheric impurities, is much more durable than iron.

There are already a few important telegraphic circuits, the conductors of which are of copper throughout, but although such lines, when in first class order, are undoubtedly superior in every respect to iron ones, it must not be supposed that the telegraph engineer is altogether in love with, aud has nothing whatever to say against them, for they appear also to excel their iron rivals in getting into all those troubles which an overhead line is heir to. And the reasons are not difficult to discover. At present copper wires are frequently run upon a set of poles already carrying a number of iron wires, and as when swayed by the wind they do not keep time with the latter, short irritating contacts are sometimes caused. Such faults can be greatly reduced by employing shorter spans; although, in this case, the remedy is almost as bad as the disease, in consequence of the serious reduction that would ensue in the insulation resistance. In fact, the more expensive metal does not have fair play in this respect, unless it has a line of poles exclusively for itself.

Again, the rust with which iron wires become coated, sometimes prevents actual metallic contact, while a copper wire preserves a comparatively clean surface; and the low resistance of a copper line allows the current caused by any given contact to rise to a much higher value than would be the case with an iron wire of perhaps treble the resistance. There is no doubt, however, that copper lines will become more reliable when the experience in erecting and jointing them has become more nearly equal to that in the case of iron.

It may thus be fairly concluded that, notwithstanding some slight disappointment which may exist in certain quarters concerning the copper lines at present in use, the question of cost is the only one which will prevent its rapidly supplanting iron, and that the troubles above mentioned will speedily diminish as its employment becomes more general.

Whenever a breakdown occurs of such a magnitude that the telegraph engineers cannot cope with it and restore communication with sufficient rapidity to prevent serious interruption to commercial traffic, the telegraphing section of the public demands the adoption forthwith of an underground system, at any rate, for the important trunk lines, either to entirely replace existing overhead wires, or to serve as a stand-by in case of failure of the latter.

We intend, presently, to discuss this underground proposal; but it is a matter for careful consideration whether the present system cannot be made so reliable as to render the adoption of the more expensive plan unnecessary. As has been remarked, the improvement in overhead construction since the lesson taught by the great storm of 1886 has been enormous, and is still proceeding. It is, in fact, safe to say, that it is possible to prevent such a complete collapse ever again occurring. But there yet remains for consideration the interruptions due to "ordinary" causes, such as the falling of a tree across a line, the slipping of a railway embankment carrying with it a set of poles and wires, or the wrecking of an important pole in a railway accident. The inconvenience attending such accidents can be, to a considerable extent, diminished by arranging that communication between important centres shall be maintained by different routes; or, to use a familiar phrase, by being careful to avoid putting too many eggs into one basket.

For instance, communication between London and Dublin is at present maintained by wires following three distinct routes; one of them going *viâ* Swindon and Cardiff to Haverfordwest, and thence by cable to a point near Wexford; a second *viâ* Chester and the secluded village of Llanfairpwllgwyngyllgogerchwyrndrobwilltysilliogogogoch (relay station), through the Holyhead-Howth cable to Dublin; and the third, which is of copper wire throughout *viâ* Worcester and Shrewsbury to Nevin, in Carnarvonshire, thence by cable to Newcastle, Co. Wicklow.

Again, an earthquake even of Javan dimensions could hardly interrupt communication between London and Berlin, unless, indeed, it happened to occur unpleasantly near either of those cities. For the London-Berlin lines also follow three distinct routes:—1. By road to Lowestoft, and thence by a cable landing in North Germany, and so on to Berlin. 2. By railway to Lowestoft, and thence by a cable landing at Zandvoort, on the coast of Holland, and *viâ* Amsterdam to Berlin. 3. From London to Dover, and thence by a Belgian cable *viâ* Brussels to Berlin.

By such an arrangement more generally applied an entire stoppage arising from any ordinary or local fault can be prevented.

It should be remarked that, in the case of inland working, the failure of even two-thirds of the lines between two first-class stations need not necessarily be accompanied by any serious delay to the traffic. When everything is going smoothly the number of lines is sufficient to enable the bulk of the messages to be transmitted by hand, each wire working duplex, and averaging, say, 70 messages per hour. When a collapse occurs, the wire or wires still left standing can be immediately switched to automatic high-speed apparatus. This can also be worked on the duplex system, and with a good wire and expert operators a constant stream of messages can be maintained in two directions at the rate of about 250 or 300 words per minute. Under normal conditions it is preferable to have a sufficient number of wires to enable the whole of the work to be dealt with by hand, as not only can the messages then be more promptly despatched, but the amount of work per man is greater, the automatic apparatus being simply held in readiness for any emergency.

But much can be done to render the restoration of any line easy and rapid of accomplishment. The first step is to quickly discover the exact locality of breakdown, and in order to do this, it is necessary to lead the wires into a comparatively large number of testing stations, and to give such stations ample facilities for prompt communication with the controlling offices. Much, then, depends upon the lineman, who is responsible for the section in which the fault occurs. The section under his care should be as compact, and all points as easy of access as possible; it should at all times be possible to inform him without delay of any interruption; he should be provided with ample means for dealing with such interruption, and, above all, be intelligent and fertile in resource. Suppose, for instance, a line of a dozen wires to be broken down by any cause, it should be possible for communication to be re-established within a very few hours by the insertion of a length of light cable in the break, and the permanent repair of the line, involving perhaps the setting of a pole, could then be effected at leisure. For this reason, it would probably be found advantageous for each store depôt to be provided with a length of about 100 yards of light cable, containing, say, a dozen wires, each end of each wire being duly numbered and labelled, so as to save the time that would otherwise be taken in identifying them. Many instances, in which serious breakdowns have been promptly met with but meagre resources, could be quoted, and also some cases in which quite the reverse has happened; in fact, few classes of men could be subjected to a sound technical training with such immediate and evident advantage as those responsible for the maintenance of important telegraph lines.

There is another advantage attending the practice of leading wires into a large number of testing stations, and thus dividing them into so many short sections, and that is the facilities which are thereby afforded for effecting "crosses," and so rendering it possible to substitute a good length of an unimportant or idle line for a faulty section of an important one in order to maintain communication by the latter at the expense of the former.

This question of facilities for crossing is an exceedingly important one. It often happens that two wires running on a set of poles are stopped each in a separate locality, and where test boxes admit of this being done, the two faulty sections can be thrown on to one wire, and communication by the other wire restored by utilising the good section of the abandoned wire. As a rule there is not much difficulty with wires belonging to one line, but the principle could be pursued further than it is were the trunk lines to meet more frequently than they do. Doncaster, a comparatively small town in itself, is of considerable importance from a telegraphic point of view, for no less than three important North trunk lines run through the test box there, and such changes as have been indicated can be readily effected; but the stretch from London to Doncaster is a long one, and it would be an advantage if another point about midway could be made similarly available. The desire to erect a line with the minimum underground work caused the new Irish route *viâ* Nevin to be taken along second-rate high roads so as to avoid the big towns, but the consequence is that the line only touches other main lines at one point this side of Worcester, viz., at Aylesbury, where it meets the heavily laden line recently erected to Manchester, Liverpool, Scotland and the North of Ireland. It would have been a great boon if the Nevin wires could have been deviated a little, so as to pass through such a town as Oxford, where the test boxes already include two important trunk lines. But to have done this would have involved the introduction of additional underground work, and it must not be forgotten that this would have prevented the accomplishment of the high speeds which have been attained on these wires, viz., 400 words per minute. We have in mind one memorable night when press work was being literally poured into Dublin (and other Irish stations simultaneously) on three separate wires, each working at this enormous rate, so that in two minutes a good column of matter was rushed through. There are many who condemn high-speed working, but there is one difficulty which such people generally overlook, viz., that to transmit the work by hand on single working circuits, a much larger number of wires would be required, and there is practically no room to erect them. Almost every main road in the country has now been studded with poles, every line of railway has also its array of telegraph poles, and most of these poles have nearly their full number of wires. It is easy, therefore, to see that to meet the ever increasing demands of the telegraphing public, it is essential to increase the carrying capacity of the wires, and this it is to a large extent which has caused the rapid increase in the number of duplex, quadruplex, and multiplex circuits. To enable these systems, together with fast speed Wheatstone, to be worked satisfactorily it is essential that long or numerous underground sections should be avoided.

(*To be continued.*)

PROCEEDINGS OF SOCIETIES.

Liverpool Engineering Society, January 21st, 1891.

THE LIVERPOOL ELECTRIC SUPPLY STATIONS.

By A. Bromley Holmes, M. Inst. C.E.

The object of the present paper is to describe briefly the central stations, machinery and appliances now in operation in Liverpool for the supply of electricity for lighting and other purposes under the provisions of the Liverpool Electric Lighting Order of 1889.

Before proceeding to describe the plant in detail a few words as to the past history of the Liverpool Electric Supply Company may be of interest.

At the date of formation of the Company in January, 1883, there was not a single installation of incandescent lamps in Liverpool, and the first building lighted by this means, in July, 1883, was the restaurant in Eberle Street, where the current was generated by a gas engine and dynamo on the premises, and the light supplied at a fixed annual charge.

About the same date the Company acquired a site and constructed its first central station in Rose Street, off Lime Street. This station was started in December, 1883, to supply electric light to the Grand and Adelphi Hotels and to other consumers in the neighbourhood, and continued without intermission in daily operation from that date till November, 1890, when the mains were connected to one of the newer stations. The capacity of the Rose Street station was under 1,000 lamps.

In 1887 a larger station was built, and commenced work in December of that year, in Tithebarn Street. This now forms part of the Highfield Street station.

In September, 1888, the Harrington Street station was completed and at work.

In 1889 the Company's new works, offices and central station were built in Highfield Street, and the supply of electricity began in October of that year.

The Company's latest station in Oldham Place commenced work in October, 1890.

The following figures show the rapid extension of electric lighting in Liverpool, the number of lamps of sixteen candle power (or their equivalent) connected with the Company's stations being as follows:—

On January 1st,	1888 ...	977	sixteen	candle-power lamps.
Do.	1889 ...	3,330	do.	do.
Do.	1890 ...	6,711	do.	do.
Do.	1891 ...	11,750	do.	do.

In the earlier stations separate engines and belt-driven dynamos were used, but these have from time to time been replaced, and the plant is now all of one uniform pattern, each engine and dynamo being combined on one bed-plate.

The capacity of the three stations now at work is as follows:—

Highfield Street ...	7,000	lamps, capable of extension to	13,000
Harrington Street ...	4,000	... ...	4,000
Oldham Place ...	4,500	lamps, capable of extension to	20,000
Total ...	15,500	Total ...	37,000

The above figures give the number of 16 candle-power lamps that the machinery is actually capable of supplying direct at one time; and as experience has shown that never more than 75 per cent. of the lamps connected to the supply mains are in use at any one hour, the above plant would have a working margin of 25 per cent. spare power for the number of lamps stated, without taking into account the storage of electricity always available from the accumulators.

The system in use is a direct current continuous supply at a pressure of 110 volts, all the mains being in simple parallel. It may be convenient to give a detailed description of the plant before describing the method of working.

The boilers are 28 feet long and 7 feet 6 inches in diameter, and are made of mild steel. The shell plates and end plates are $\frac{5}{8}$-inch thick, and the ends are strengthened by gusset stays. The boilers have two flues 3 feet diameter, tapered to 2 feet 6 inches diameter at the back end, and made of mild steel plates $\frac{7}{16}$-inch thick, and each flue is fitted with six steel Galloway tubes. The working pressure is from 110 to 120 lbs. per square inch.

Of the 10 boilers in use seven are fitted with Proctor's mechanical stoker, and the remaining three with Viccars's mechanical stoker.

The water supply is taken into the storage tanks from the town mains, and, where practicable, a duplicate service has been carried into the station from a second main.

Two feed pumps (or a feed pump and injectors) are provided at each station, and a complete double system of feed pipes, with separate check valves, on each boiler.

Feed water heaters are used, and an arrangement of valves, by which, in case of any breakdown of a heater, the water can be sent direct to the boiler or pumps without passing through the heater.

The steam and exhaust pipes are divided into sections, so that any necessary repairs may be effected without stopping the station.

The engines are Willans central-valve compound engines of two sizes, ten of them being of the I.I. size, with cylinders 14 inches and 20 inches diameter and 9-inch stroke, capable of indicating 180 horse-power, the remaining three engines being of the G.G. size, with cylinders 10 inches and 14 inches diameter and 6-inch stroke, indicating 60 horse-power.

All the engines, which are single acting, have two cranks placed on opposite sides of the crank shaft. Each line of pistons is connected to its corresponding crank by a pair of connecting rods, between which work the eccentric and eccentric rod which actuate the valve gear. The eccentric is forged solid on the crank pin.

Piston valves are used, working inside the hollow piston rod which connects the pistons.

All the moving parts are in constant compression and subject to a downward thrust.

At the top of the engine is the steam chest, common to both lines of cylinders. Underneath the steam chest are the high pressure cylinders; next, the low pressure cylinders; and underneath these latter the guide cylinders, which act as air cushions.

A sight feed lubricator is provided on the steam chest, and a grease cup on top of each line of cylinders for giving a flush of oil if needed.

The chamber in which the cranks work is filled with water up to the level of crank shaft. A small proportion of castor oil is added to the water, and is churned up with it by the movement of the cranks and effectually lubricates the internal bearings.

The governor is fitted directly on to the end of the crank shaft and actuates an equilibrium throttle valve, fixed at the entrance of steam chest.

The bed-plate of engine is extended to carry the dynamo.

Each engine is fitted with a cylindrical steam separator, which ensures a supply of dry steam.

The dynamos have magnets of the single-inverted horse-shoe type, with massive wrought-iron limbs. The armature shafts are coupled directly on to the crank shafts of the engines.

The dynamos for the smaller engines give an output of 300 ampères, and an E.M.F. of from 110 to 140 volts, at from 450 to 500 revolutions per minute.

The larger dynamos give 900 ampères, and from 115 to 135 volts, at 375 revolutions per minute.

Some of the dynamos are compound wound, but the later patterns are plain shunt wound, and all have a variable resistance attached to them, by which the current through the shunt circuit can be varied and the E.M.F. regulated at will.

Two of the dynamos were manufactured by Crompton & Co., and the rest by Siemens Brothers. In the Crompton dynamos the resistance of the armature is ·0028 ohm and of the shunt coils 11 ohms.

The armature is built up of charcoal iron discs keyed directly on to a steel shaft $5\frac{3}{4}$ inches diameter. The core is 36 inches long and 18 inches diameter. The effort is transmitted from the shaft to the discs by the feather, and from the discs to the winding by means of delta metal driving teeth fixed in holes drilled in the core. The winding consists of eighty turns of pressed stranded bars, measuring ·6 inch by ·63 inch in section. These bars are made slightly taper, so that they may lie evenly against each other. The armature bars are connected by copper end connections, turned right and left on what is termed the butterfly plan. The commutator is made of cast copper sections, and is $9\frac{1}{2}$ inches in diameter and $8\frac{5}{8}$ inches long.

In the Siemens dynamos the resistance of the armature is ·0024 ohm and of the magnet coils 6 ohms.

The armature is constructed with a core of thin sheet-iron discs threaded upon a round steel shaft. The core is insulated and surrounded with 144 insulated bars, each bar consisting of a number of wires stranded together and pressed into a square shape. The insulated bars are connected to one another and to the commutator, as usual in drum armatures. The armature is bound with bands of steel wire to resist the centrifugal force generated whilst revolving.

The accumulators have lead containing boxes, each about 4 feet long by 12 inches wide and 13 inches deep, supported on heavy wood slabs resting on glass insulators.

The cells are of two kinds, manufactured respectively by the Electric Construction Corporation (formerly known as the Electrical Power Storage Company), and by the Crompton-Howell Electrical Storage Company. The Construction Company's cells are of the well-known L. type, E.P.S. pattern, manufactured as follows:—

The grids are cast in iron chills, the negatives of lead-antimony alloy, and the positives of lead. Both kinds of grids are pasted with red lead mixed into a paste with dilute sulphuric acid, and are then dried and put into the forming tanks. Charging is commenced with a current density of two ampères per positive plate, increasing up to four ampères, the total number of ampère hours being about 100 each for the positive plates, which are then removed, and their places taken by blind positives, with which the completion of the forming of the negatives, which require about 200 ampère hours per plate, is continued. When formed, the plates are taken out of the tanks and burned together in sections as required. Each central station cell has three sections of twenty-seven plates each, or eighty-one plates in all, each plate measuring 9½ inches by 9 inches by $\frac{3}{16}$ths inch thick.

The maximum safe rate of discharge of the cells is 250 ampères, and the storage capacity about 1,700 ampère hours at ordinary rates of discharge.

The plates of the Crompton-Howell cells are composed of porous lead, the structure of the plates being entirely crystalline and presenting a large surface to the electrolyte. The active material is formed electrically right through the plate and does not readily fall away, but adheres firmly to the lead.

The plates are mounted on celluloid racks resting on the bottom of the cells, and are kept apart at the top by celluloid combs. The plates are not connected into sections, but the positives of one cell and the negatives of the next are burned on to a common lead bar, supported on insulators between each cell.

Each cell has fifty-one plates 8½ inches by 8½ inches by ⅛-inch thick, and may safely be discharged at the rate of 400 ampères, having a storage capacity of 800 ampère hours when discharged at the normal rate of say 200 ampères.

All the distributing mains of the Liverpool Electric Supply Company are laid underground, and have been manufactured and laid by the Callender Company.

The conductors are of stranded-copper wire, with a conductivity of 98 per cent.

The largest feeding mains are composed of ninety-one No. 9 wires, and have a sectional area of 1·57 square inches. The conductor is covered with two layers of jute yarn and boiled in refined bitumen. It is next wrapped with parchment tape and covered with a lead casing. The lead is protected by an outside covering of rough jute yarn treated with asphalte and tar.

The ordinary feeders are made of sixty-one No. 11 wires with an area of ·6 of a square inch, and the distributors of thirty-seven No. 13 wires one quarter of a square inch in area. In both these mains the copper conductor is covered by a solid sheath of bitite or vulcanised bitumen put on under heavy pressure at one operation. This core is next taped and compounded, and finally braided with hemp yarn and passed through a bath of asphalte compound.

The mains are laid in cast-iron troughs ⅜-inch thick and about 6 feet long, with socket joints. When the troughs are placed in position about ½-inch of refined bitumen in a molten state is run in, and, before setting, spacing bridges of wood are placed in it about 18 inches apart. These bridges support the cables and hold them in place, clear of the sides and bottom of the trough and of each other. Bitumen is then run in so as to entirely cover the cables and fill up the iron troughs to within ½-inch of the top. The troughs are then finished by a covering of Portland cement concrete about one inch thick. Strong cast-iron covers are in some cases substituted for the concrete.

The service lines from the distributing mains to the consumers' premises are made of nineteen No. 14 wires, insulated and covered with lead pipe, and are run in wood grooved casing, filled in with bitumen and protected with a hard-wood cover strip.

The connections of the various lengths of mains to each other, and of the feeders to the distributors, are made by sweating copper lug pieces on to the ends of the cables and by bolting copper connecting bars to the lugs.

The distributing mains are jointed in a similar, way, the connecting bars being fitted with terminal screws for the attachment of fusible tin strips, to which the service lines are attached.

The connections described above are made in cast-iron joint boxes, measuring inside 16 inches by 12 inches by 12 inches, provided with socket pieces to receive the ends of the cast-iron troughs in which the mains are laid. Each box has a strong cast-iron cover held down by a central bronze bolt and crossbar. A watertight joint is secured by means of a soft Indiarubber washer between the cover and the box.

All joint boxes are below the level of the pavement, and the surface of the footway is completed by an iron frame and surface plate, by means of which access is afforded to the joint box. In many cases the surface plates are formed in cement to match the adjoining paving.

The general arrangement of mains is as follows:—A pair of distributing mains are laid under the footways on each side of each street, and are connected together to form a complete distributing network, to which are connected all the service lines to consumers' premises. For convenience in working the network is divided into sections. The supply of current is brought to selected distributing points in this network by heavy feeding mains, which run direct from the generating stations.

The feeding mains are so proportioned relatively to the distance from the station of each distributing point and the number of lamps to be supplied from it that the percentage of loss in pressure in each feeding main may be as nearly as possible the same; in other words, if the lamps were turned on and off uniformly all over the area of supply, a constant pressure might be maintained throughout the network by varying the E.M.F. of the dynamos at central station in exact proportion to the amount of current supplied.

As a matter of practice, however, the hours of demand vary in different streets and districts, and it is found necessary not only to vary the station pressure as a whole, but also to regulate the pressure for each set of feeders individually, The following figures will give some idea of the extent of the mains already laid:—

The district served by the mains extends 1,300 yards (measured straight on map) from Lime Street to bottom of Brunswick Street, 1,000 yards from Old Hall Street to Head Post Office in Canning Place, and 1,550 yards from Highfield Street to top of Bold Street and Wood Street.

The length of frontage along which distributing mains are laid is nine and a quarter miles. The total length of single cable used throughout the area is forty-one miles. Taking a pair of cables to form a main, the lengths of the various classes of mains are as follows:—

Feeding mains	10	miles.
Distributing mains	9	do.
Service lines	1½	do.
Total ...	20½	miles.

The weight of copper in the mains is 210 tons.

The number of joint boxes, service boxes, and pressure wire boxes is 630.

The number of separate service lines is 275, but many of these serve for the suppply of several consumers.

Pressure wires are run in specially-laid cast-iron pipes from the various distributing points to the central stations, and are connected to instruments, by means of which the actual pressure at each point is indicated to the engineer in charge and is continuously and automatically registered.

The main switchboard in each station is fitted with an ammeter and registering pressure indicator for each pair of feeders.

These street mains are connected up to massive terminals on the switchboard fitted with safety cut-out strips, which would fuse in the event of any serious short circuit on the main.

All the dynamos in a station are arranged to work in parallel on to a pair of positive and negative collecting conductors, and are switched in and out of circuit as the variations in load require.

Each negative feeding main is connected from its cut-out to the station main negative conductor, and each positive feeding main is connected through an ammeter to a main regulating switch, which, when in its normal position, completes contact with the station main positive conductor. By moving the regulating switch it is possible to introduce a number of accumulators, one after another, in the circuit of any desired feeder. These accumulators are arranged in opposition to the dynamo current, and consequently, the pressure in the feeder is reduced by two volts for each cell put into circuit by the regulating switch.

This at first sight may appear a wasteful method of regulation, but in practice the load is found to rise so uniformly over the whole area of supply that the amount of energy absorbed in regulation is practically unimportant.

The battery of accumulators at each station is capable of supplying 500 lamps at a time, thus enabling the machinery to be stopped at from 10 to 12 o'clock at night and in some cases entirely on Sunday, and also largely in the day time in summer. The discharge from the accnmulators is registered by a recording ammeter. By a special arrangement of dividing the accumulators into sections, devised by the author, they are charged from the dynamos supplying the town at the ordinary working pressure, and by a little care it is in this way possible to so regulate the load on the engines and dynamos as to run them at their highest efficiency.

The very great advantage of this will be appreciated from an inspection of the efficiency diagram of one of the 900 ampère sets of plant, from which it is seen that the electrical efficiency (that is to say, the ratio of the external electrical output of the dynamo to the indicated horse-power in the cylinders) is as follows:—

At 150	ampères or	⅙	load	50 per cent.
„ 300	„	⅓	„	65 „
„ 600	„	⅔	„	79 „
„ 900	„	full	„	86 „

Continuous tests of the insulation resistance of the mains are made at each station by means of a special apparatus devised by the author for this purpose. If two lamps be connected in series between the positive and negative mains, and a point between the lamps be connected to the earth, the lamps will be found to burn with a variation in brilliancy proportional to the relative insulation resistance of the mains to which each lamp is attached. If two voltmeters be substituted for the lamps their readings will indicate the same ratio. In the apparatus referred to, a registering voltmeter is used to indicate this ratio continuously. By a suitable arrangement of switches, an ammeter with one terminal connected to earth can be momentarily connected to either main, and the insulation resistance in ohms of the main to which the instrument is not connected is readily arrived at by dividing the station pressure in volts by the number of ampères indicated by the ammeter. For example, if the station pressure be 120 volts and the ammeter reading 3 ampères, the resistance of the opposite main would be 40 ohms.

The ammeter used for testing must be accurate at low readings, and therefore is only made to read up to 5 ampères. In the event of any dead earth fault on the mains, the instrument might be destroyed by the sudden rush of current, and to prevent such an accident a magnetic cut-out is placed in series with the ammeter. When more than 5 ampères passes through the cut-out it breaks contact, leaving in circuit a resistance coil of 25 ohms, so that the current through the instrument, with a station pressure of 125 volts, cannot exceed 5 ampères. By this contrivance it is possible to measure faults of very low resistance.

The Hookham electric meter used by the company consists of a simple electromotor doing work against the retarding influence of Foucault currents generated in a copper disc rotating between the poles of a permanent magnet. The armature coils are built up on the copper brake disc, and the axis carries a worm which actuates a train of counting gear. The meter is calibrated so that the dial reads directly in Board of Trade units. The speed of rotation (subject to a small frictional error at small loads) is proportional to the current.

Diagrams are exhibited which show the very variable demands made on central station plant at different hours of the day and at various seasons of the year. From these it will be seen that the number of

Board of Trade units per lamp per month varies from 6·3 units in January to 1·2 units in June. Also, that in December the output reaches 4,060 ampères, whilst in June it does not exceed 500 ampères.

This paper has been limited to the description of the central station plant and appliances of the Liverpool Electric Supply Company, and to the method of working simply from an engineering point of view, and no attempt has been made to deal with commercial details either of capital expenditure or working costs, which may be more usefully brought before this society, after longer experience, at a future date.

Manchester Association of Engineers, Saturday, January 24th, 1891.

DYNAMOS: THE CONSIDERATION OF THE CHIEF FEATURES WHICH REGULATE THEIR APPLICATION.

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The continuous current dynamo, which can alone engage attention to-night, consists in its most usual form, of a fixed magnet and a rotating armature, separated by a narrow air space. Under the influence of the magnet, the air space between the polar surfaces and the armature core experiences a change of condition, which constitutes what is known as a magnetic field, and the whole activity of the machine is centred in the armature conductors as they revolve in this field. A difference of electrical pressure is constantly maintained along their length, and when their ends are connected through the brushes to the external circuit, so as to form a closed system, a current of electricity is established. The pressure is proportional to the strength of field and to the rate at which the conductors cut it.

If iron filings be sprinkled on a surface placed in front of a magnet, they arrange themselves in lines, having definite directions and more or less densely distributed, in different parts of the field, fig. 1, whence Faraday derived the conception of defining its strength as proportional to the lines contained in a given area. In a dynamo the field is produced by means of an electro-magnet, the construction of which will be familiar to all. The current round the magnet is said to induce the lines of force. or to give rise to an induction, and these lines in turn induce a current in the moving conductors.

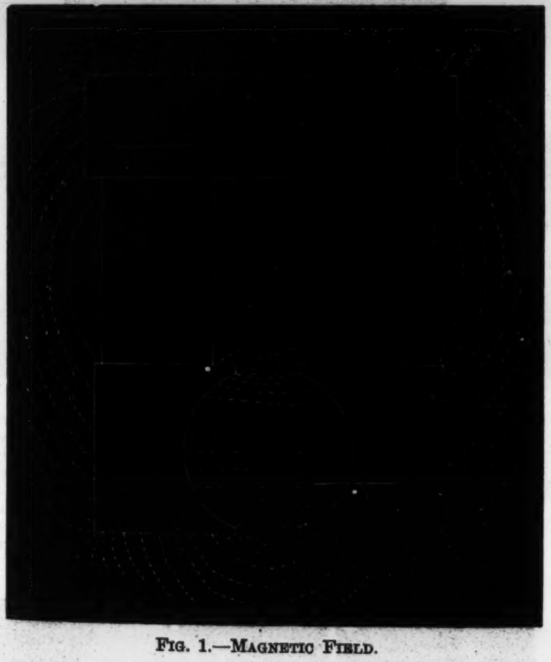


Fig. 1.—Magnetic Field.

The effect which a magnet has on a compass needle, and the powerful way in which it attracts iron from a distance, are well marked evidences that the induction can be transmitted across space, and it is impossible to resist the conclusion, that this can only occur through the agency of a strain of some sort, produced in the intervening medium or dielectric, following the course of a closed circuit running through the iron and crossing from pole to pole, as delineated by the lines of force. Now a field identical in its properties with this magnetic field, surrounds every conductor along which an electric current is flowing, the lines of force being circular, with the conductor threading through them. Such a field is essential for the propagation of current, and whatever affects the strength of one, also affects the other, consequently by interlinking a magnetic with a conducting circuit, as is done in a dynamo, and giving them a relative movement so as to vary the number of lines enclosed, a displacement takes place which is in the nature of a flux. The field owes its properties to the dielectric being able to withstand the application of the stress, but in the conductor, as its name implies, the field breaks down, and the power, which has to be continually supplied to build it up again as the conductor moves into a fresh position through the field, is conducted away, to reappear as current energy in the circuit, where it can be either reconverted into mechanical energy by acting on another magnetic field, stored up as latent chemical energy, or dissipated in light and heat.

The effect may be popularly likened to that of a pump, employed to circulate water in a closed system of pipes, and it is no more necessary to suppose that the dynamo creates electricity than that the pump creates water. The electricity may be regarded as lying dormant in the system, until set in motion by the pressure generated in the revolving armature, when it makes its presence felt by giving rise to what we call an electric current. In the pump, work is done in lifting the water against an opposing head and in overcoming friction, and the measure of the work done in a given time, is the product of the head of water into the quantity. In the dynamo, work has to be done in order to drive current through the circuit against the opposing pressure or resistance, and the rate at which it is done, is measured by the product of the pressure into the current. The unit employed for reckoning the pressure is called the volt, and for the current the ampère, and for their product the watt, of which 746 are equal to one horse-power. The other quantity with which we are concerned is the resistance, which is the name employed to express the opposition to the passage of the current, offered in greater or less degree by all substances; its unit is called the ohm. The product of resistance into current is equal to the pressure, so that loss of pressure, due to resistance between any two points in the circuit, is proportional to the current flowing:—

$$\text{C R} = \text{E}$$
$$\text{E C} = \text{W}$$

where
C = current in ampères R = resistance in ohms.
E = pressure or electromotive force in volts.
W = power in watts.

The strength of field obtainable with the same strength of magnetising current varies enormously for different substances. This is expressed by saying that their permeability to the lines of force is different. The permeability of air may be taken as unity, and is independent of the intensity of the magnetising force. In soft iron, with very high magnetising force, the induction may be pushed to over 30,000 lines per square centimetre, but as shown in the curve, fig. 2, where the relation between magnetising force and induction is plotted, there is a falling off in the permeability as the magnetisation increases. In iron it is probable that every molecule is already a magnet, but as far as external action is concerned, the resultant force is nil, which Professor Ewing has recently shown there is reason to believe, is because the molecules under their mutual attraction form groups, in each of which the magnetic circuit is closed on itself. When, however, the iron is subjected to a magnetising force, such as is produced by passing an electric current round it, these groups are broken up, and the molecules tend to set with their axes parallel, so as to form a continuous magnetic circuit through the whole length, with poles at the bounding surfaces of the extremities. The rotation of the molecules is not, however, proportionate to the strength of the current, and to make them assume their ultimate positions, with poles at right angles to its direction, would require an enormously strong current, hence the falling off in permeability

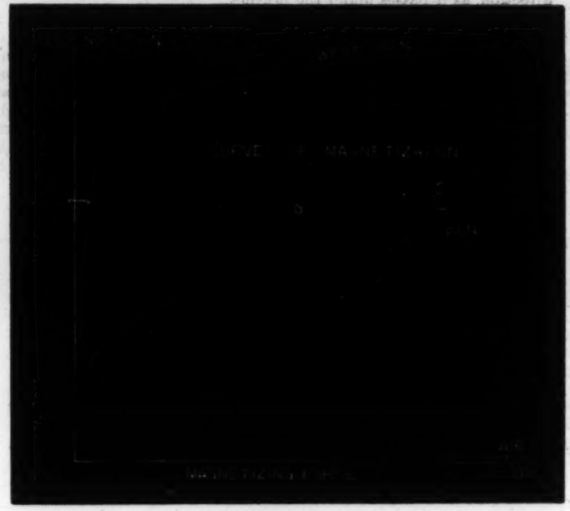


Fig. 2.

If the path traversed by the lines of force for the whole of their length was through air, as would be the case with coils enclosing no iron, their number would be enormously reduced, and they would be scattered. The coils necessarily take up a good deal of room, so the length of the magnetic circuit has to be considerable, but with iron present, the force is handed on with nearly as full intensity as if all the coils were packed into a thin belt close to the armature, and the length of the circuit proportionately reduced; so that in the dynamo the part performed by the iron is one of concentration.

All armatures are built on one or other of two fundamental types, the drum, fig. 3, in which the conductors are all wound externally, and the ring, fig. 4, in which they envelope both inside and outside of the iron core. As the connections for each are analogous, it will suffice in tracing the action to select the ring winding as an example. A core is built up of thin iron rings, electrically separated from each other by means of such material as paper, this is done to prevent heating due to currents which if it were composed of a solid mass, would circulate through the length. By means of a non-magnetic spider frame, this core is secured to the rotating shaft. On it are wound the insulated conductors, in the form of a closed spiral, the external part of every turn of which cuts the magnetic circuit twice in a revolution, the impluses of each turn being added. The ends of each section of the spiral are connected to a pair of commutator bars, on which the brushes rest, and by which communication with the external circuit is established.

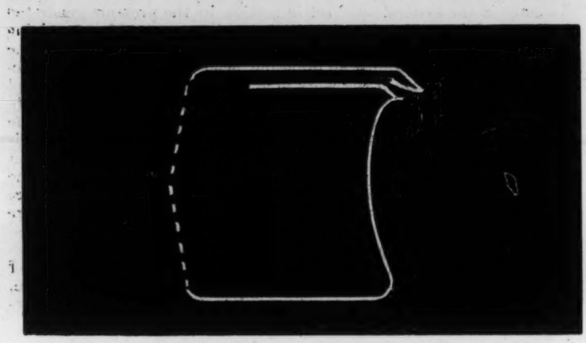


FIG. 3—DRUM ARMATURE WINDING.

The commutator is built of bars of copper insulated from each other, and the brushes are set to bear on diametrically opposite sides; each bar in turn is brought into action twice in a revolution, and conveys the current alternately in a positive and then in a negative direction, as it passes under the brushes.

The direction of the current in the conductors is shown on fig. 5, by means of arrows, and the commutator bars, which for sake of clearness are reduced in number, are shown with their connections, the sections being defined by the portions contained between contiguous bars. It will be seen that the currents in each half converge on the brushes, and as each section belongs first to the right and then to the left, two impluses are given to it in each complete revolution. As the armature revolves, the sections now belonging to the side marked south, pass to the side marked north, and below in the reverse order. The lines of force, which cross between the poles and the armature, are cut by the conductors on the right from below, and on the left from above, hence on either side the currents will flow in opposite directions round the spiral, the two streams entering the brush in the same direction.

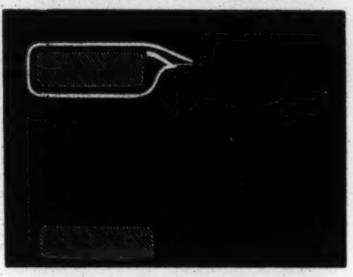


FIG. 4.—RING ARMATURE WINDING.

These currents surrounding the iron core necessarily magnetise it, and the polarity which they impart differs in direction to that of the field magnets. The two sets of lines of force are superimposed, with the result that a fresh distribution of field is produced, fig. 6, and the line dividing the core into two halves, across the diameter at which the lines of force enter from one side and emerge from the other, which is called the neutral line, is now oblique to the plane of symmetry. Changes in the strength of the current cause the position of the neutral line to change. The brushes to work without sparking have to be set a little in advance of it, and when its position changes, the brushes have to follow suit. This occasions the need for attention in working the machine, as there is always excessive wear of the commutator when the brushes are improperly set, and an accurate comprehension of what takes place is of material assistance in the management. In fig. 5 the section shown is just on the boundary between the lines of force entering the core on one side and emerging on the other, where the field is nil, so that comparatively little difference of pressure exists between contiguous bars, and the section has just been closed on itself by the two commutator bars being bridged by the brush. Up to this point the section has been carrying the same amount of current as all the other sections on the same side which are in series with it, but now being momentarily short-circuited, the strength and direction of current will depend on the field through which it is passing. To prevent sparking, the brush has to be set in advance of the neutral line, at the point where the density of the field is just sufficient to stop the current, and raise it in the opposite direction to the same strength as that flowing in the coils on the side to which it is just passing.

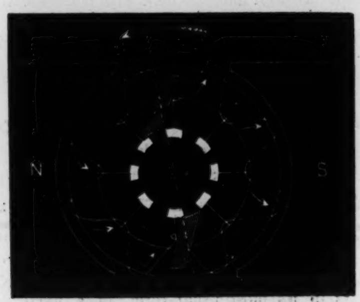


FIG. 5.—RING ARMATURE CONNECTIONS.

Now, in virtue of the property of self-induction possessed by an electric current, which is greatly augmented by the presence of iron in the core, and which is analogous to the inertia of a ponderable body, the current contains a small store of energy, and this has to be given up before the current can be stopped, and in raising it again in the opposite direction, energy is absorbed, both in consequence of the self-induction and the resistance of the section. The amount involved varies as the square of the current strength, therefore with heavy load a stronger reversing field is required. It, however, unfortunately happens that the obliquity of the field due to the armature reaction, increases with current in a direction which leaves the brush in a weaker field, whereas a stronger one is wanted, hence when load is added, it is always necessary to advance the brushes in the direction of rotation, into a stronger field. If they are not placed far enough forward to effect complete reversal by the time commutation ends, the progress of the main current from the left is impeded, owing to self-induction, so that at the moment when contact is broken, part only finds its way through the section, and the rest forms an arc between the edge of the bar and the brush; and, again, if the brush is set so far forward as to effect more than complete reversal, the excess

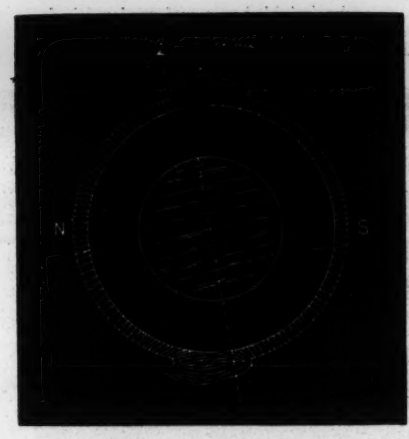


FIG. 6.—ARMATURE REACTION.

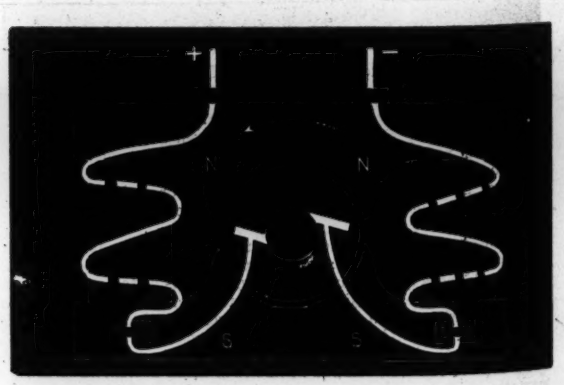


FIG. 7.—MANCHESTER DYNAMO. COMPOUND WINDING.

of current set up can only spend its energy by likewise causing sparks.

In a motor supplied with current in a like direction, the position of the neutral line remains the same, but the direction of rotation is reversed, so that now the action of the field on the section, even before commutation commences, is tending to reverse the direction of the current. The sequence of assisted and retarded motion remains the same as in the generators, and the brush has still to be set on the same side of the neutral point, the lead, as the displacement of the brush is technically called, now becoming negative and will have to be increased with load in the direction opposed to the rotation.

No machine has hitherto been constructed with an absolutely fixed position for non-sparking point, but to a great extent it is under control, by proper shaping of the pole pieces and by increasing the strength of the field, when as fewer turns of the conductor on the armature are required to produce the pressure, the obliquity of field and self-induction are reduced. The energy of the spark can also be diminished by multiplying the number of sections; in small machines this can be pushed to the point at which the commutator bars become so thin that a brush of proper thickness to collect the current without heating, would bridge more than two bars at a time, and in large machines, to the point at which each section only contains one convolution. Thus in a small Manchester dynamo for 100 volts and 24 ampères wound with 480 convolutions, the number of commutator bars cannot conveniently be increased above 40, whilst in an Edison-Hopkinson dynamo for 105 volts, 1,100 ampères, only 43 convolutions are required to obtain the electromotive force, and in larger machines a limit is reached at which the possible number of sections in the commutator is so small, that the great difference of pressure between them makes an adjustment of the brushes to prevent sparking almost impossible.

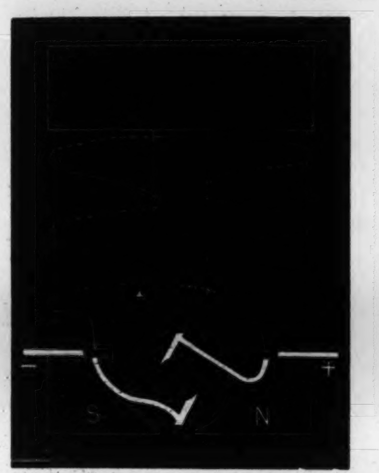


Fig. 8.—Edison-Hopkinson Dynamo. Shunt Winding.

Fig. 9.—Proportions of Edison 60 Light Dynamo.

The field-magnets next engage attention. They may be made either with double or single magnetic circuit, as the Manchester and Edison-Hopkinson machines, figs. 7 and 8. The single circuit is the most simple. and will best serve for illustration. The best results are obtained with wrought iron, because, as may be seen from fig. 2, more intense magnetisation can be obtained with less expenditure of force. This, however, chiefly resolves itself into a question of cost and expediency. In some machines cast iron is exclusively used, and in some, as the Manchester, there is a composite circuit. In the Edison-Hopkinson only the softest annealed wrought iron is used throughout.

The lines of force in passing from pole to pole choose the path of least resistance, only those penetrating the armature core being effective. Owing to the small distance between the core and the polar surfaces the major portion pursue this course, but inevitably some, emanating chiefly from the outside of the pole pieces, pass external to the armature and are wasted, and if other masses of iron, such as the bed-plate, are in too close proximity, an undue number may be lost, and even in the best designs the amount is from 20 to 25 per cent.

The larger the section of the armature core in proportion to that of the magnet the less strongly it will be magnetised; it attracts more lines and reduces the waste, but the increased quantity of iron enclosed by the armature conductors tends to increase the obliquity of the field, so that less current in proportion can be carried, and it is therefore desirable to take a mean value; this when only wrought iron is used, is arrived at when the permeability of the armature core is only slightly greater than that of the magnets.

It is undesirable, on the score of economy, to saturate the iron by magnetising it beyond the point at which the permeability begins to fall away rapidly. On the other hand, if the induction is too low, any irregularity in load or speed is liable to produce magnified fluctuations in the pressure.

It is important that the bored faces of the pole pieces should embrace the greater part of the circumference of the armature, otherwise the area of the air space across which the lines of force have to pass, being restricted, a greater magnetising force is required, and there would be more waste field. In very large machines, however, restriction becomes a necessity, for without it the balance between the current turns on the armature and the magnets could not be maintained.

It will often be found that in machines with a weak field the tendency to sparking is corrected by increasing the interval between the polar tips, this being necessary to insure proper gradation of field for reversal, but the lead is then considerable. In the Manchester dynamo, in which the field is powerful and the air space small, the reduction in the gap between the tips to five degrees or even less decreases both speed and lead. In this case there can be little doubt that the leading convolutions of the section under commutation enter the field on one side of the neutral line before the rear one emerges from the field on the other side, and so reversal is expedited, and the lead varies less with different loads.

The number of current turns required to give the same magnetisation to iron is proportional to its length, no greater length of magnet limb should therefore be used than is consistent with a sufficiently shallow winding to allow the heat to escape. Fig. 9 shows the proportions of Edison's 60-light dynamo, as brought over to this country nearly ten years ago, and the dotted line of the keeper shows the reduction in length made by Dr. J. Hopkinson, whereby, still using nearly the same weight of copper, he was able to produce a field of so much greater strength, that it permitted of a fresh arrangement of the armature conductors, and the machine gave double the output.

Two different methods of winding magnets are employed. For series wound machines the main on its way to the external circuit is carried round the magnet limbs, using a thick wire with few turns, fig. 7. In shunt winding, fig. 8, a separate circuit of many turns of fine wire proceeding directly from the main terminals is employed, carrying only a small current. Compound winding is a combination of both methods; each has its special applications, but in all the same magnetisation is produced, provided the product of the current into the number of turns is constant. Owing to the loss of energy which takes place in sending a current through a conductor against its opposing resistance heat is always generated, and the dimensions of the wire have to be proportioned accordingly. In series winding the length is determined by the number of current turns required, and the section by the strength of current. In shunt winding there is for every machine a proper diameter of wire proportional to the linear dimensions and to the electromotive force, which gives the right number of current turns, but the length is arbitrary; if it be doubled the resistance is doubled, and the current therefore halved, but the total current turns remains nearly the same. In practice the length is therefore determined solely by considerations of economy. With the longer wire there is less loss of energy and therefore less heating, but increase beyond a certain length is prohibited by the expense. For small machines, where the radiating and conducting surfaces are proportionately large and the depth of winding small, the heat can readily escape, and 2,500 yards to 3,000 yards for every 100 volts at the terminals is sufficient. In large machines, especially when high efficiency is aimed at, double this length is sometimes used.

Of the total pressure generated, part is absorbed in overcoming the resistance of the armature and the magnet winding, the rest being available at the terminals for use in the external circuit. With increased load more energy is required to drive the increased current round the armature, and at the same time the reaction on the magnets is increased, those coils included between the brush and the line dividing the armature symmetrically between the poles, act in direct opposition to the magnet coils, tending to weaken the field, whilst the remainder tend to twist it. And the greater the twist the greater the lead, so that unless the magnetising force or the speed is increased, the pressure at the terminals must fall as load increases. In the shunt machine this occurs in three-fold manner, as the reduction of pressure at the terminals, consequent on the armature loss and the lead, results in less current being driven round the magnets. The effect in the series machine is different, the pressure being augmented, because the magnets being excited by the main current increase in strength as it rises.

(To be continued.)

LONDON CHAMBER OF COMMERCE ELECTRICAL TRADES SECTION.

The Electrical Trades Section Committee of the London Chamber of Commerce met last Monday at Botolph House, Eastcheap, Mr. R. E. Crompton in the chair.

Modifications in Telephone Provisional Orders.

This was the first item on the agenda. The Secretary read over the clauses it was proposed to modify, with the modifications proposed, and also a memorandum which was to be sent to the Board of Trade on this subject.

The Chairman said this was a question of the highest importance. It was the first time there had been an attempt to constitute a legal property in the space surrounding an underground wire. They had now an opportunity of expressing an opinion to the Board of Trade and of endeavouring to arrive at a *modus vivendi* satisfactory alike to telephone and electric wire companies.

Colonel Jackson protested against any resolution from this committee being presented to the Board of Trade. Nineteen-twentieths of its members represented one interest—the electric light—though the magnitude of the telephone interest was quite as great. Their report would be accepted by the Chamber of Commerce, as a matter of course, and thus a heavy blow be struck at the telephone interest.

Mr. Morse said that the "A" clause in the 1889 orders was a clause of agreement between the electric light and telephone companies, and when in 1890 the Board of Trade proposed to alter it, and they had protested against such alteration being made without their consent, the chairman of the committee held that in every case where an objection was raised the clause agreed on should be kept in the orders. This year the Board of Trade had sent him a draft of the model order. and asked for remarks upon it. That was about the end of November. He forwarded that draft model to this committee, and on the fourth of December he was instructed to reply to the Board of Trade objecting to the alterations in the telephone clauses in the model order, but the Board of Trade made no reply beyond merely acknowledging the letter.

Colonel Jackson said he thought that the feeling of the telephone companies was that the order of 1889 originally agreed on would have been acceptable to them if inserted in every provisional order. It had been said that the Board of Trade had not authority enough to settle the matter, and had refused to settle the order. Also that it must go before the Committee of the House of Commons, and the result was the provisional order which appeared in the latter portion of last year. Notwithstanding that the Board of Trade had sent another form of provisional order entirely new to both parties, they (the telephone companies) had objected to the proposal, had had an interview with the Board of Trade on the subject, and would have much preferred remaining as they were. Eventually the Board of Trade had sent them an amended form, which no doubt was the same as that now before the committee; but if it was the wish of the gentlemen connected with the electrical trades to return to the order of 1889, they would find no opposition from the telephone companies. He would suggest that Messrs. Morse and Winterbotham should meet on this matter, and see if the electric lighting and telephone companies should take joint action.

Mr. Winterbotham said that the proposed alteration would place electric light people in this position. They might be called on to alter the positions of their mains whenever it was found that telephone wires either existing, or hereafter to be laid down, would be seriously affected.

The Chairman remarked that it was the "hereafter to be laid down" which was the objection.

Mr. Winterbotham said that the words were qualified by those following: "The intention of the clause was to prevent electric lighting companies from laying down wires of such character as would prevent telephone wires being laid down."

Colonel Jackson said that as regarded current, it was clear that the telephone current would not injure anyone; it was so light. It would be no advantage to the electric lighting companies if the telephones had an insulated return, but the electric lighting companies saturated the earth and monopolised it.

After a lengthy discussion, Messrs. Jackson, Garcke, Morse and Winterbotham were appointed a sub-committee to consider the matter and report.

Overhead Wires.

The Secretary having read some correspondence which had passed between the London Chamber of Commerce and the Board of Trade on this subject,

The Chairman said that the point was that the Board of Trade had formulated certain rules, and were assisted by the committee of the council of the Institution of Electrical Engineers. These rules were confessedly tentative, intended to be put on their trial. They had been put on their trial and found extremely onerous and restrictive to the industry. The Board of Trade had taken no notice of repeated letters, and they wished to force their hand and to get the sympathy of the scientific world. They had shortened up the correspondence as much as possible, and proposed to circulate it among the scientific world and hear their views.

On the motion of Mr. Price, seconded by Mr. Garcke, it was resolved that the report should be printed.

Electrical Standards Committee.

The Secretary explained that some correspondence had passed between him and the Electrical Standard Committee of the Board of Trade. He had been invited, if it was found that all interests were not represented, to forward the names of any gentleman capable of giving valuable evidence. He had replied, submitting the names of a number of gentlemen, and still further urging that the gentlemen representing supply and light companies should be added to the committee. The Board of Trade replied that they had nothing to add to the last previous letter.

The Chairman said that this was another case in which the Board of Trade thought they could prepare rules and get assistance in the way of preparing standards on which all legal cases connected with the measurement of electricity would ultimately depend without in any way consulting the people practically engaged in using those standards. The mere giving of evidence was not of nearly so much value as a seat on the committee, and there was not a commercial firm but which had its scientific member who was as well qualified to sit there as any of the present members.

Proposed Exhibitions of Electrical Appliances in London.

A letter from Mr. Seymour Wade suggesting that an exhibition of electrical appliances be held in London was taken as read. A letter from Major Page condemning the scheme was read, and it was resolved that it should be drafted into a reply. The secretary was instructed to reply to the St. Pancras Vestry informing them that the committe were of opinion that an electrical exhibition would be of no use at St. Pancras.

Automatic Electric Signalling.

Mr. Perlo had written proposing to address them on the subject "Is railway travelling safe as managed at present."

The Chairman thought it would be very difficult to get an audience together in the afternoon, and would suggest that the address be delivered to the electrical or mechanical engineers. This was approved of.

LONDON COUNTY COUNCIL.

The report of the highways committee of 22nd January, 1891, states the following:—We have considered a notice (Registered No. 153), with three plans, from the Electricity Supply Corporation, dated 12th January, 1891, of intention to lay distributing mains (1) along the Strand from Bedford Street to Trafalgar Square, (2) in King William Street and Charing Cross Road to Leicester Square, and (3) from St. Martin's Place across Trafalgar Square and Charing Cross, and along Cockspur Street to the Haymarket. The proposed interference with the carriage-way of the Strand is to be deprecated; and, although the company has statutory power to lay its mains there, we have conferred with the company's representatives with a view to some alternative route being adopted for the mains, by which this interference could be avoided. We have satisfied ourselves that the adoption of any other route would involve a very large extra expenditure, which in our opinion the council could not fairly require the company to incur; but we have impressed upon the company's representatives that the work of laying the proposed mains in the Strand must be carried on with the greatest expedition, and with the least interference with the traffic. To the laying of the mains in the other thoroughfares referred to in the notice there does not appear to be any objection; but those for Charing Cross Road should be placed in the subway there, and those for the other thoroughfares should be laid under the footways wherever it is found practicable to do so. We recommend:—That the sanction of the council be given to the works referred to in the notice (Registered No. 153), dated 12th January, 1891, of the Electricity Supply Corporation upon condition that the laying of the mains in the Strand shall not be commenced until the company has sufficient material upon the ground for the completion of the works; that the company do give four days' notice to the council's chief engineer before the works are commenced; that they shall be carried on continuously by day and by night with as little interruption to the traffic as possible, and shall be completed within a fortnight from the commencement; that the company shall pay the cost of supervision of the work by the council's officers; that the number of cables shall be limited to that shown upon the index plan, marked E, submitted by the company; that the mains for Charing Cross Road shall be placed in the subway there; that the positions to be occupied by them in the subway shall be subject to the approval of the chief engineer of the council, and that the work of placing them shall be carried out to his satisfaction; that the mains in the other thoroughfares referred to in the notice shall be laid under the footways wherever it is found practicable to do so; that the concrete floor of the road-boxes shall be 9 inches thick, and the York stone at the top 4 inches thick; that the space between the casings of the mains and the underside of the paving shall be filled in with concrete; and that the longitudinal girders in all the boxes shall be laid on 3-inch stone templates the full thickness of the brickwork. That the clerk be instructed to forward to the Electricity Supply Corporation a notice requiring it to lay the mains for Charing Cross Road, referred to in the notice dated 12th January, 1891 (Registered No. 153), in the subway of that thoroughfare.

We have considered the following notices of the London Electric Supply Corporation—14th January, 1891 (Registered No. 154), of intention to lay distributing mains in the following streets, &c., in the parish of St. George, Hanover Square—Hanover Square and Street, Princes Street, George Street, Brook Street, Upper Brook Street, Park Lane, Oxford Street, Davies Street, Mount Street, Hill Street, New Bond Street, Carlos Street, Grafton Street, Albemarle Street, Dover Street, Half Moon Street, Clarges Street, Hay Hill, and Down Street (1 plan). 14th January, 1891 (Registered No. 155), of intention to lay distributing mains in the following streets, &c., in the parish of St. James, Westminster—Oxford Street, Poland Street, Great Marlborough Street, Wardour Street, Glasshouse Street, Brewer Street, Lower James Street, Little John Street, Great Windmill Street, Golden Square, Great Pulteney Street, Piccadilly, Coventry Street, Clifford Street, Old and New Burlington Streets, Saville Row, Cork Street, and Sackville Street (1 plan).

The proposed works are of the same description as those of this company previously sanctioned by the council; but the plan submitted with the second of these notices shows that the mains are to cross over the subway of Shaftesbury Avenue at a slight depth below the surface of the road, and some extra precautions should be taken for protecting this short length of main. We recommend that the sanction of the council be given to the works referred to in the two notices (Registered Nos. 154 and 155), each dated 14th January, 1891, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work in any thoroughfare; that the mains be laid under the footways, and be kept 9 inches below the underside of the paving, wherever it is found practicable to do so; that where the mains cross the carriage-ways they be kept at the same depth below the concrete or the road material, as the case may be; and that the mains to be laid across Shaftesbury Avenue shall be protected with an extra covering in order to diminish risk of accident or injury.

LEGAL.

Motion against M. Secrétan.—The case of Strauss *v.* Goldsmid came before Justices Cave and Williams in the Queen's Bench Division, on Saturday, in the form of a motion by the plaintiffs, Messrs. Strauss and Co., metal merchants, for leave to amend their writ in the action which they had brought against Goldsmid to recover about £500,000, by adding as a co-defendant, M. Secrétan, a resident of Paris, and the late managing-director of the Société des Métaux. Leave was asked to serve notice of this writ on M. Secrétan, out of the jurisdiction of this Court. Mr. Boyd, in supporting the appeal, said that since the action was commenced the plaintiffs had ascertained that M. Secrétan was in partnership with Goldsmid and that both were connected with the Société des Métaux, which was formed with a capital of 70,000,000f., for the purpose of acquiring the whole stock of copper in the market, and of controlling prices. The plaintiffs' case was that the contract was made on behalf of M. Secrétan as an undisclosed principal, and therefore M. Secrétan ought to be joined in the action as a defendant. Mr. Reid, Q.C., in opposing the motion, contended that as the plaintiffs had allowed 12 months to elapse since the issue of the writ, they ought not to be allowed to come forward now and join M. Secrétan. Their Lordships adjourned the hearing of the motion until 13th February, to allow an affidavit to be obtained from Paris.

The United Telephone Company, Limited, and Another v. Andrew Erskine Muirhead.—In this action the United Telephone Company, Limited, and the National Telephone Company, Limited, London, sue Andrew Erskine Muirhead, merchant, Cart Forge, Crossmyloof, Glasgow, to have the defender interdicted from infringing the letters-patent, dated July, 1877, granted to Thomas Alva Edison, of Menlo Park, New Jersey, U.S.A., for the invention of "improvements in instruments for controlling by sound the transmission of electric currents, and the production of corresponding sounds at a distance," and from making, using, and exercising or vending during the continuance of the letters-patent the invention described therein. £500 is sought in name of damages for the alleged infringement, and delivery is also sought of all instruments possessed or controlled by the pursuer, including the "Ader" transmitters, which are made in infringement of the letters-patent, and also all instruments made according to the manner described in the letters-patent, dated December, 1876, granted to William Morgan, of Brandon, and Morgan-Brown, engineers, London and Paris, for the invention of "improvements in electric telephony (transmitting or causing sounds for telegraphing messages) and telephonic apparatus," a communication from abroad by Alexander Graham Bell, of Boston University, U.S.A. The letters-patent in question are vested in the United Telephone Company, subject to certain rights to the National Telephone Company. The pursuers say that the defender has been violating their letters-patent by erecting telephone transmitters and receivers of the "Ader" type. The defender says that the statements of the pursuers, so far as material, are unfounded in fact, and that he ought to be assoilized. The record was closed to-day, and the case sent to the Procedure Roll. Counsel for the pursuers—Mr. Dickson. Agents—Davidson & Syme, W.S. Counsel for the defender—Mr. Watt. Agents—Clark & Macdonald, S.S.C.

Maxim-Weston Electric Light Company.—The case of the Maxim-Weston Electric Lighting Company, Limited, against Palmer's Shipbuilding Company, which was part heard last Friday, came before Mr. Justice Stephen and a jury again on Monday last. The plaintiffs sought to recover £264 15s. 9d. for work done in fitting up one of defendants' vessels with an installation, and the defendants repudiated payment on the ground that the work was not carried out according to contract, and counter-claimed for damages.

His lordship said this was a case for a reference, and could not be tried by a jury. Unless another referee was agreed upon, he should send the case to the Official Referee.

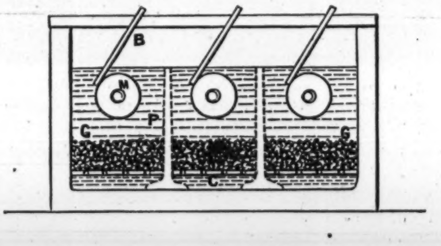
ELMORE'S PATENT ELECTRO-DEPOSITED COPPER.

ON Tuesday a number of Press representatives were invited by Elmore's Patent Copper Depositing Company to view their works at Haigh Park, Hunslet, near Leeds, and we desire to express our sense of satisfaction, at least so far as we are concerned, at the admirable manner in which the Company arranged the trip. The programme was carried out in the following order :—

1. Visit to the melting shed where rough Chili bars are melted and converted into convenient form for introduction into the depositing tanks.
2. The dynamo room, where there were three machines of Mather & Platt's manufacture, 50 volts and 750 ampères, and three Willans and Robinson's engines, one to each dynamo.
3. Inspection of the depositing tanks.
4. Visit to the machine shop where the process of removing the copper tubes from the mandrels was seen, and finally a few minutes spent in the testing room where a piece of copper was broken.

The *modus operandi* of the Elmore process, as seen on Tuesday may be briefly explained. The rough Chili bars, containing 97 per cent. of copper, are melted in a furnace, and then ladled out and dropped into a tank of water, the copper being afterwards taken out in the form of large granules, technically termed "shot copper." These are carried into the depositing room and packed on perforated copper plates at the bottom of each of the 60 tanks, to the depth of some inches, so forming the anode. The tanks or baths are about 12 feet by 20 inches, by 3 feet 6 inches, and contain one, two, or three iron mandrels 10 feet 6 inches long, according to diameter; these vary from 4 to 18 inches. The tanks are connected in series, and about forty were in working operation during our visit. The mandrels revolve in the tanks by means of chain gearing connected at one end of each bath, each set being actuated by pulleys attached to a long line of countershafting running the length of the tanks. It will be seen that the deposition on the mandrel takes place from underneath, and the circuit is completed by brushes similar to those used for dynamos, rubbing on one end of each mandrel. The burnisher, an agate, the face if which is about half-an-inch square, moves slowly from end to end of the mandrel, the travel taking twenty minutes, every part of the copper surface thus receiving a rubbing under slight pressure

The appended sectional sketch of a bath will give a very fair idea of the arrangement, only that the burnisher is not shown. M are the mandrels, in this case three; G the "shot" or granulated copper packed on the perforated copper plate, C, and B the brushes attached to a metal strap going across the end of each tank. The burnisher in each tank is attached to a long shaft extending over all, so that they move backwards and forwards together. The uprights, P, in dotted lines, represent cast copper plates extending the length of the bath to form side anodes, although, for some inscrutable reason, they were not being used, the deposition in the tanks taking place, as we have previously said, from underneath. We were informed, however, that the tanks would eventually be so fitted up, so we need not say anything further on this topic, or we might have asked whether the laws of electrolysis were perfectly understood by the officials in charge of the works. The current used was said to be 750 ampères, and the E.M.F. at each tank terminal about ·9 volt; we had no means, however, of verifying these figures, nor were we able to obtain any definite data of the working expenses, beyond the vague statement, already so well known, that the cost is



far less than that of any other process hitherto in use. Every mandrel has to be first coated with a film of copper in a cyanide bath before it is introduced into a tank for the purpose of forming a tube upon it, and after the proper thickness of metal has been obtained there is the process of removing the tube and recoppering the mandrel, although here again it was stated that an improvement recently made would eventually obviate this last mentioned operation. The removal is effected by letting the mandrel with its copper sheathing revolve, while a machine having a couple of rollers running, under pressure, at right angles to the tube above and beneath it, passes slowly along its length and loosens the copper from the iron ; it is then taken to another machine and the tube pulled off the mandrel.

The single plant in operation is stated to be capable of yielding a deposit of some 5 tons per week of 168 hours, but the process generally seems to be very slow and tedious. The specimen of copper cut circumferentially from a tube which we saw tested gave an elongation of 21 per cent., and the breaking strain represented 21 tons on the square inch ; the grain was certainly very beautiful. It is not, however, such details as these which should be placed before the public, but an actual balance sheet giving the cost of raw materials, labour, and management on the one side, and the profit, if any, accruing from the sale of manufactured articles on the other. We offer a few further comments in our leading pages, the above being sufficiently graphic to give an idea of the Elmore process, which is at present solely devoted to tube making. but we cannot rid ourselves of the impression that the wilderness of unfinished buildings on the Company's land will turn out to be a sad waste of bricks and mortar, although we would willingly hope against hope that such a misfortune may yet, by some lucky stroke of good fortune, be averted.

PRACTICAL PHOTOMETRIC RESEARCH.

By RALPH RICHARDS.

AMONG the many questions which affect civilised life, that of artificial illumination occupies a prominent position, deciding as it does, in a certain measure, the successful accomplishment of many and various projects.

In almost all cases solar is preferable to artifical illumination ; since, however, continuous solar illumination is a physical impossibility, it becomes necessary to supplement this somewhat desirable state of affairs with the best possible substitute for the solar rays.

The object of the following articles is to place upon a firmer basis than has heretofore been attempted the subject of practical photometry. It has occurred to the writer that perhaps the most adequate manner in which to deal with the question at issue, is to divide the subject into three sections, of which the first deals with the fundamental principles of physiological and physical optics, the second being devoted to a description of the instrument which the writer has devised for use in the subsequent investigations, and a third section containing a *resumè* of various measurements, experiments, and of facts connected with the subject of photometry.

SECTION I.

Notes on Physiological and Physical Optics.

Sight may best be defined as the sensation which enables us to decide as to the colour, distance, and geometrical form of an object. This sensation is produced on the excitation of the optic nerve, by certain undulatory waves which we are accustomed to call light. It is unnecessary to go deeply into the anatomy of the eye ; to do so, indeed, would be beyond our limits ; but a slight explanation may perhaps be of advantage. The organ of vision really resembles a camera obscura in its construction ; light rays entering the eye passing through a double concave lense (termed the crystalline) ; thence through a circular aperture in the iris (termed the pupil), which is capable of automatic dilation and contraction ; again, through a medium termed the vitreous body, the object of which seems to be the correction of chromatic aberration ; finally, to impinge upon the surface of the retina, into which ramifies the optic nerve, whose function is to convey the sensation of sight to the brain.

It is still a matter of speculation as to the real image-receiving surface of the retina ; owing, however, to the circumstance that we are unable to perceive single objects, amongst a group which together subtend an angle of less than 40 seconds with the optic axis of the eye, and also to the fact that the retina is studded on its surface with fine club-ended rods (technically termed Jacob's membrane), whose separate distance apart likewise agrees with the subtention of the angle already mentioned ; it seems probable that these are the real nervous connecting link.

This theory is further strengthened by the following circumstances : (1) That light waves, from their undulatory character, would seem well calculated to excite these rods ; (2) Lateral pressure or the transmission of sonorous vibrations laterally upon the eye produce luminous sensations ; and (3) Electrical currents will also produce the same effect. The writer has observed in his own case, in regard to the last method, that more powerful effects are produced by currents flowing laterally than directly through the eye-ball ; this fact seems in contradiction to the undulatory theory of electrical discharges. But this is a retrogression.

The iris has, as has been previously notified, the power of automatic contraction and dilation.

The greatest dilation of the pupil occurs when the eyelids are opened in the dark ; if gradual homogeneous illumination then ensue, the pupil (or more correctly speaking the iris) will contract in proportion to the increment of illumination, until, when the luminosity becomes so great as to exert a hurtful influence upon the optic nerve the eyelids close naturally.

If, then, the eye be directed towards a large and brilliantly illuminated area, the iris will, as we have seen, contract to a certain extent ; let us then suppose this area to be a large, circular surface ; and that, as we observe it, the edge gradually loses brilliancy, whilst the complementary portion gains in illuminative power ; colloquially speaking, the light gradually retires from the edge of the circle and accumulates proportionately towards the centre. This disparity continuing the pupil will gradually contract, until, if the final central illumination be sufficiently powerful, the eyelids will close. That this is so, was first suggested to the writer when observing these changes in the pupil of a cat's eye during the gradual emergence of the sun from such a uniformly cloudy sky as usually is the premonitor of a fine day. Now, owing to the fact that the various component rods of Jacob's membrane are ultimately connected with the brain, and gain their sustenance conjointly from the same source, it follows that homogeneous illumination is not necessary to produce "optical exhaustion ;" for it seems almost as a natural sequence that, however the luminosity be distributed over the retina, the same optical exhaustion will be produced relatively to the main nutritive source, although the sections which are least exhausted will recover first. The phenomena of irradiation and of colour blindness are easily explained by applying the undulatory theory to the physiological one already generalised ; for if it be an accepted fact that there are three primary colour sensations, responding respectively to the red, green and violet rays (a view which is supported by both Maxwell and Helmholtz on very good grounds), we can suppose that light waves are capable of imparting vibrations to the rods of Jacob's membrane in three separate planes (it being supposed on this hypothesis that the resultant path due to the vibrations of any light ray is solely governed by the preponderance and proportion of the constituent rays which affect either of the three possible paths).

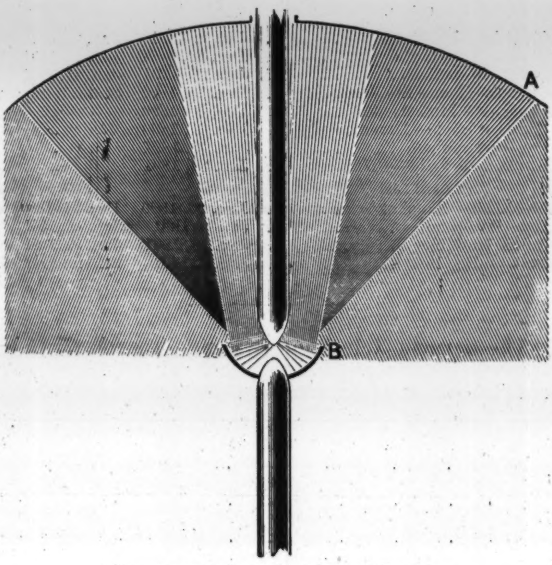
If now, owing to some physiological defect, these rods are incapable of vibrating sufficiently in either of the three possible planes ; the result, as anticipated, will be inability on the part of the person affected to adequately perceive these colours. This view is still further supported by the fact that the phenomenon of colour blindness most frequently affects the red and green colour sensations ; moreover if the rods are merely capable of vibrating in one path or plane, we should expect the phenomenon of monochromatic sight ; a state of affairs which sometimes is found to exist.

The phenomenon of irradiation is easily to be accounted for on the above hypothesis, although a description would be without the province of these articles.

Before closing the strictly physiological section it may be well to state that the contraction of the iris is governed by the resultant optical exhaustion; consequently if we are observing a large area, which is uniformly, though slightly, illuminated at all parts, except in one locality where the light is of dazzling brilliance. The iris will be closed in proportion to the resultant action of the illuminated area; since, however, the disparity is, in this case, very great, this adjustment or contraction will be approximately correct in regard to the higher but far too great relatively to the area of lower illumination; hence, although perhaps sufficiently brilliant, yet owing to the great contraction of the pupil, due to the more brilliant light, it (the area) appears to be but indifferently illuminated.

This is precisely what occurs in relation to arc and to some of the higher candle-powers of incandescent lamps; when our eyes encounter not only those rays which are reflected from the illuminated surface, but also those which emanate directly from the radiant matter; and, as is well known, if these latter be screened from the eye, the result is as might be anticipated, a far greater efficiency, owing to the immediate dilation of the pupil, and consequent entrancement of visual power.

Now it will be at once seen from this circumstance that such illumination would be considerably enhanced by appliances (1) for the purpose of screening the arc from the eye, and (2) for enlarging the radiating surface; and for this purpose the writer recommends some arrangement, such, for instance, as the apparatus he has illustrated in the annexed figure.



A, large concave mirror; B, small parabolic mirror.

This consists of a small parabolic mirror, B, which screens the arc from observation, and causes the downwardly-emitted rays to be reflected upwards, together with the upwardly-emitted rays to the second and slightly concave mirror, A, the surface of which consists of facetted silvered glass of frosted silver; or in fact, of any good dispersive surface whence the rays are dispersed in all directions to the ground; this arrangement will be found to possess advantage over the usual methods (viz., milk glass globes), for the arc is by this arrangement absolutely invisible, whilst *all* the rays are utilised, and a somewhat smaller area illuminated; the author has merely tried the experiment roughly, but he feels confident that as no greater percentage of light than 30 per cent. is lost after the partly double reflection against the milk glass globes, which absorb about 60 per cent. of the light, and of the transmitted 40 per cent. fully 50 per cent. is useless, being radiated above the horizontal line; thus the efficiencies of the mirror arrangement to the globe are in the ratio of, say, 25 to 70. An arrangement, of which this is an improvement, was exhibited by Jaspar at the Paris Exhibition some years back, and was much admired for the beautiful softness it imparted to the rays, although he did not, I believe, employ a frosted nor a small parabolic mirror, his arrangement merely shutting off the arc from observation, and reflecting the upwardly emitted rays downwards. Since, however, but a small proportion of the total radiation is of upward emission when constant currents are (as is usually the case) employed, the efficiency of his apparatus could not have been great.

It will have heen seen from the preceding remarks that some law of efficiency should be deduced; that is, a law expressing as a ratio the relative illumination of the object to be illuminated and of the photometric intensity of the light source, and this is, as will readily be seen (to a certain extent) a ratio between surfaces, for it is desirable within certain limits that the radiating surface should be as great as possible for any dispersion agreed upon, and this is the only law which decides the physiological-photometric intensity of any light. Physicists do not seem to have recognised the distinction between the quantity and intensity of a luminous source. Mr. Varley pointed this out some time past, and made also some very admirable observations regarding coal fires; the writer remembers noticing a very similar phenomenon some 10 years ago, when crossing a canal bridge late at night; the brilliance suggested the appearance of nitre burning in a coal fire. As an illustration of the quantitative and intensitive conception of light we may say that the quantity is a question of extent in square inches of radiative surface, and that the intensity is the total luminous radiation per square inch, thus we have a complete analogy to the electrical law W. = E. × C.

The question of lighthouse illumination is a weighty one, and physicists differ greatly as to the proper means of obtaining the best results; some have averred that the electric arc is out of the question, using as a convenient handle the great inefficiency of this light to penetrate London fog; now, this is obviously a great error, for London fog, being surcharged with matter which absorbs almost all but the red, orange and yellow rays, is consequently a very unfavourable medium for conveying the light emanating from the arc, which is particularly rich in the very rays which are so largely absorbed by this form of fog; on the contrary, sea fog being white deals impartially with all rays, hence it follows that the question is not one of colour but of efficiency, white light is unquestionably the most efficient for visual purposes, and the only approximately white light which is capable of being produced at present on a commercial scale is that of the electric arc; surface, again, is another question, and obviously, in this case, an all-important one, for sea air is impregnated with particles of spray which may be considered to be loosely distributed; several of these would cause a far greater diminution of luminous power in a small than in a large beam; and, further, it may be taken for granted that a large beam is more efficient than a small one on the following assumptions, which the author thinks are well borne out by known laws: A foggy atmosphere is one in which particles of foreign matter (generally moisture) are suspended; a beam of light being directed through such will be partly dispersed, owing to reflection from particle* to particle; the beam will consequently be *widened*, but there will be a limit to this widening, for light will be reflected inwards from exterior particles, thus practically no light leaks, so to speak, above a certain distance; if two circular beams be considered one, having at the commencement of its journey from the radiant a vastly greater area than the other; we can now decide as to the efficiency; both beams lose a certain percentage of rays due to dispersion, as explained, but as the larger beam offers, so to speak, a far smaller *leakage* surface in proportion to its area (the leakage surface being, of course, the circumferential limit of the section of the beam) than is the case with the smaller beam, the leakage will, of course, be proportionately less,† and since both beams, after travelling through equal distances, are caused by proper lenses to so converge, that they both illuminate equal areas, it will be seen that the larger beam has the advantage, and that, supposing the candle-power to remain constant, the larger a beam is at its commencement, and consequently the greater the radiative surface of the illuminant, the higher will be the resulting efficiency for such purposes where a beam of light is desirable, such as in lighthouse illumination, where the purpose is chiefly to penetrate a foggy atmosphere.

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* This is, of course, the cause of the white appearance of the clouds, the grey and black clouds being caused by the diminution of light which occurs when much reflection and re-reflection occurs, which is the case when there are many suspended particles of vapour.

† The rapidity of cooling observable in wires of small cross-sections is, of course, to be attributed to the same circumstance.

It will become obvious that the improvement the author suggests in regard to ordinary arc lamps is also capable of application to those designed for use in lighthouses when suitably modified; hence it will have been seen that the physiological inefficiency of the arc lamp, in proportion to its great photometric intensity, may be remedied with success.

NOTES.

Electric Lighting at Bournemouth.—At a meeting of the Town Council, last week, it was reported that a letter had been received from Messrs. Learoyd, James and Mellor, on behalf of the National Electric Supply Company, Limited, stating that their application for a provisional order was too late for the coming session, and asking if the corporation would grant a license to them on their undertaking to apply for a provisional order next year. The committee recommended that such license be granted, and the report was adopted. The committee also reported the receipt of a communication from the Board of Trade, asking for the observations of the council as to the proposed amendment in the system of laying the mains under the Electric Lighting Brush order and the committee, after careful consideration, recommended that a reply be sent to the effect that the council would approve of metal water-tight conduits being used, but would object to concrete ones, and that the council, anxious to conserve the safety of the public in connecting consumers with the high pressure system, suggested that compliance with the current rules of the Phœnix Fire Office, with regard to transformers, be enforced. This was also adopted, and on the recommendation of the Roads Committee a proposal of the Brush Electrical Engineering Company was approved of to lay down an underground wire system along the Poole Road.

Electric Lighting of Bristol.—According to the scheme of electric lighting which the electrical committtee has decided on, street lighting and private lighting will be kept entirely distinct, different dynamos working the separate circuits. There will be 100 street lamps of 1,000 C.P. each, fixed at an average distance of 50 yards apart, some along the kerbstone and some in the centre of the roadway. Half of these will be turned out at midnight; but even then the light will be twice as effective as the present illumination by gas. The committee are now awaiting advice from Mr. Preece as to the character of the boilers, engines, and other machinery to be adopted.

Electric Light at the Royal Naval Ball, Devonport.—On the occasion of the late ball given at Keyham barracks, in honour of the Duchess of Edinburgh, the ball-room and the whole of the buildings were lighted for the first time by the electric light. The installation was carried out by the electrical and engineering staff of the H.M.S. *Defiance* torpedo school at Devonport, under the superintendence of Lieut. Orpen of that ship. The current was supplied from three dynamos, two on board H.M.S. *Racoon*, and one on a torpedo boat, all of which were more than 1,000 yards away from the barracks; over 6,700 yards of armoured electric light cable were used for mains, and for completing the circuit a steel hawser and the iron work of the pier was utilised. Owing to the considerable distance between the dynamo and lamps, and the small size of cable used, there was a great loss in transmission; the E.M.F. at the dynamos was 80 volts, and in the buildings 42-volt lamps were used in groups of eight. Although only used two nights, considerable trouble was taken to make the light perfect, and the result may influence the Admiralty to light the building permanently.

Electric Lighting of Trains on an Irish Railway.—On Thursday last, the Great Northern Railway of Ireland ran a train from Dublin to Drogheda and back which was lighted by electricity. The experiment was entirely successful.

Electric Lighting of a Village Church.—A gentleman living at Penally, in South Wales, who has recently had his house fitted with the electric light, has had the wires conveyed into the village church, as also into a reading room which he has provided for the people of the village. This is said to be the first church lighted by electricity in South Wales.

Electric Lighting of Norwich.—The Provisional Order applied for by the Norwich Electricity Company was discussed at the last meeting of the Norwich Town Council and did not give complete satisfaction, first because of the limited area to which it applied, and, second, the length of time—42 years—within which the Corporation could not purchase. It was decided, however, not to oppose.

Ship Lighting.—The ss. *Lightning* was launched on Tuesday from the yard of Messrs. Henderson, Partick, for Messrs. Apcar & Co. The vessel is to trade between Calcutta and China, and will be lighted thoroughly by electricity by the Woodside Electric Works Company.

Interruptions and Repairs to Submarine Cables and to Land Lines to January 25th, 1891:—

Cables.	Date of interruption.	Date of repairs.
Chorillos—Mollendo	Jan. 8, 1891	Jan. 9, 1891
Odessa—Constantinople	Dec. 22, 1890	Jan. 12, 1891
Ceara—Maranham	Jan. 20, 1891	Jan. 21, 1891
Jamaica—Ponce Sta. Cruz ...	Dec. 15, 1890	Still interrupted.
Benguela—Mossamedes	Dec. 20, 1890	„
Constantinople—Dardanelles ...	Dec. 31, 1890	„
Para—Maranham	Jan. 12, 1891	„
Santiago de Cuba—Cienfuegos ...	Jan. 31, 1891	„
Land Lines.		
Moulmein—Bangkok	Dec. 30, 1890	Dec. 31, 1890
Indo-European	Jan. 9, 1891	Jan. 12, 1891
Cuban land lines	Jan. 13, 1891	Jan. 20, 1891
Transandine line	Jan. 8, 1891	Still interrupted.

The German Telephone System.—The following table shows the increase in telephonic communications between the terminations of the years 1888 and 1889.

	End of 1888.	End of 1889.
Places supplied with urban telephone systems	174	198
Length of lines in urban telephone systems	3,485 miles	4,207 miles
Length of conductors in urban telephone systems	31,476 „	40,264 „
Number of central telephone offices ...	139	216
Number of telephone posts exclusive of official ones	32,858	42,132
Number of instruments employed on urban telephone service	38,694	50,259
Number of subscribers for the common use of the urban telephone systems ...	30,171	38,877
Number of lines connecting the urban systems of different towns	166	196
Number of telephone communications passed between central offices	149,511,616	204,280,899

The above figures do not include the statistics for Bavaria and Wurtemburg.

The German Telegraph System. — The following statistics are taken from an article in the *Journal Télégraphique* on the German telegraph system:—

		End of 1889.
Length of telegraph lines		61,150 miles.
„ „ conductors		207,634 „
Government telegraph offices		12,431 „
Railway and other offices open to private telegraphy		3,977 „
Number of instruments in service		24,264 „
Number of telegrams sent during 1889:		25,847,836 „
Internal	17,953,419	
To abroad	3,285,175	
From abroad... ...	3,638,736	
In transit	970,506	

Proposed Extension of the Electric Railway to Peckham.—A memorial has been drawn up and largely signed by inhabitants of East Dulwich and Peckham, praying the local authorities to increase the railway accommodation of the district. The London and Brighton trains run only to the south side of London Bridge, which is very inconvenient in bad weather, so the Camberwell Vestry will ask the directors of the electric railway to extend their system by way of Walworth Road, Camberwell Green and Peckham Road to East Dulwich and Nunhead.

The Effects of the American Snowstorm.—The snowstorm which raged over the American continent on Saturday night, reduced the telephonic, telegraphic, and electric light systems to chaos. On Sunday night not a single lamp dependent on a supply company was burning. In the lower part of New York, where the old-fashioned telegraph poles were still standing, the streets were blocked with a number of prostrate poles and miles of entangled wires. Business on Monday was practically at a standstill all day, for all the merchants and brokers had been almost entirely cut off from communication with the outside world. The telegraph companies are the heaviest losers by the storm, as it is estimated that the damage done to the various lines will reach at least half a million dollars. Fifteen hundred wires were rendered completely useless, and it will require at least two weeks to put them in working order again. Only two telegraph wires were workable out of New York, one to Chicago and the other to Albany. All the newspaper and commercial and private wires are down, and the local newspapers appeared on Monday with nothing but European news in the matter of telegraphic information, and very little of that. The telephone wires have suffered most from the storm in the city, the telegraph wires being mostly underground. The Metropolitan Telephone Company report that from 2,500 to 3,000 wires are broken, the cost of repairing which will amount to at least 150,000 dollars. The Western Union Telegraph Company are at present unable to form an idea of their loss, which is, however, very heavy. Outside New York the damaged wires extend from Philadelphia to Boston, as far uorth as Poughkeepsie, and as far west as Carbondale. Beyond these points the snow was dry, and no damage is reported; but within these limits the loss is estimated at over one million dollars.

A Singular Request.—Emma Abbott, the famous opera singer, whose death recently occurred, left instructions in her will that her body be cremated after a thorough test by electricity. It is said that Miss Abbott had a great fear of being buried alive.

The Proposed Central Railway.—At a meeting of the Commissioners of Sewers, held on Tuesday, it was resolved to petition against the Central London Railway and the City and South London Railways Bills to enable the commission to offer such opposition as might be deemed expedient.

Electrical Apprentices and Employers.—Among the applicants to Mr. Sheil at the Westminster Court on Monday were two young men of very respectable appearance, who complained that as apprentices to a firm of electrical engineers they were last week suspended from work by the manager because they would not consent to work for nine hours more a week than they had been doing. As a matter of fact, they had already worked three hours more weekly than they undertook to do on the signing of their indentures, with which a premium of fifty guineas was paid in each case. The only excuse put forward for the fresh demand was that the new management considered it necessary.—Mr. Shiel asked them if they had a copy of their indentures.—The applicants said they had not. They had never had a copy given to them.—Mr. Sheil: Your position entirely depends on what is in the indentures. You may be bound to comply with rules made at any time. One of the young men said he would go and demand a copy of the indenture. Mr. Shiel: Ask for it civilly. A respectable firm will not refuse you a copy.

The Frankfort Exhibition.—The committee of this exhibition states that the Oerlikon Engineering Works were to have commenced, on the 24th inst., to make experiments with the extra high tension which it is proposed to employ in transmitting current from Lauffen, on the Neckar, to Frankfort.

New Electrical Journal.—A new electrical journal called the *Exportzeitung für Elektrotechnik*, has been started in Hamburg to promote the export of German electrical appliances. The journal is published in German, English and Spanish, and appears fortnightly.

The Tivoli Waterfall.—The Minister of Public Works has declared to be of public utility the project of erecting a large station at Tivoli for the electrical transmission of power to Rome.

Lecture.—On Thursday evening, the 22nd inst., Mr. Henry Edmunds delivered a lecture before the Streatham and Tulse Hill Institute on "The Applications of Electricity." The lecture hall was well filled with an appreciative audience, who followed the lecture with marked intelligence and enthusiasm. The generation and application of the electric current was described and explained with the aid of a full set of apparatus, the lecturer dwelling more particularly upon the use of electricity for motive purposes, giving some figures showing the rapid development of electric tramways in the United States, compared with the slow progress made in the same field in this country. Various articles illustrating the domestic application of the current to such humble offices as heating irons, and boiling water, were inspected with considerable interest, and several electric motors demonstrated the transmission of power. Mr. Edmunds also exhibited his phonoscope, which renders visible the changes in the diaphragm of a telephone, and also his electrical gyroscope, describing the possibilities of such an instrument. By the courtesy of the National Telephone Company, the lecture hall was placed in communication with their service, and Mr. D'Oyley Carte having kindly allowed his stage telephones to be employed, the audience were enabled to hear the opera of the "Gondoliers" performed at the Savoy Theatre. We hear also that a more novel and important feature was a line which connected them to the Theatre Royal, Manchester, enabling them to hear the pantomime which was at that moment delighting the inhabitants of Cottonopolis. The lecture room was lighted electrically, and the various experiments were completely successful.

The School of Electrical Engineering and Submarine Telegraphy.—The manager of this school, Mr. L. Drugman, informs us that as the result of recent examinations the following students have now obtained the vellum certificate of the school:—(A.) *In Electric Lighting and Power Transmission:* Messrs. A. C. D. Crommelin, B.A.; J. Finlay, J. F. Ingens, H. Macfarlane, L. Marchetti, F. J. Moffett, B.A.; R. J. F. Mostyn, J. W. Parr, P. F. W. Simon, P. J. S. Tiddeman, H. Treherne, L. W. Wild, C. B. Wigg. All these students belonged to the advanced class; instructor, Mr. Charles Capito, M.Inst.M.E., M.Inst.E.E. This examination was conducted by Mr. Gisbert Kapp, M.Inst.C.E., M.Inst.E.E., and consisted of a paper in mechanical engineering, a paper in electrical engineering, a *viva voce* and practical examination and drawing. (B.) *In Telegraphy and Telephony*, Mr. H. Treherne, above-named. This examination was conducted by Mr. H. R. Kempe, A.M.Inst.C.E., M.Inst.E.E., of the Engineer-in-Chief's office, General Post Office.

Oxygen.—The 'Bill promoted by Bowman's Oxygen Lighting Company which would have empowered it to lay mains all over the metropolis has been dropped and electricity has another lease of life. The streets have had one violent upheaval and will be none the worse for being quiet for a time.

O.S.A.—On Saturday, January 24th, a most enjoyable evening was spent at Prof. Perry's house, 31, Brunswick Square, Mrs. Perry having kindly invited the members of the Old Students' Association of the City and Guilds of London Institute to an "At Home." A very excellent programme of music was provided:—violin, Miss Edith Doughty and Mr. Gatehouse; 'cello, Mr. Roger Bucknall; vocalists, Miss Cherry and Mr. Howden Tingey; pianoforte, Miss Margaret Doughty and Mr. C. G. Lamb. In all there were about 200 persons present, most of whom were students and their friends, but in addition to these there were several distinguished electrical and scientific men, amongst whom we may mention Prof. Ayrton, Prof. Meldola, and W. H. Preece, Esq., F.R.S.

City Electric Lighting.—The first portion of the electric lighting cable in the City will, we learn, be laid on Tuesday, the 3rd prox. The Lord Mayor, it is hoped, will be present on the occasion.

The Lane-Fox Patents.—After some lengthy negotiations between the Lane-Fox Electrical Company, Limited, and the St. James's and Pall Mall Electric Light Company, Limited, an arrangement has been arrived at by which the St. James's Company have acknowledged the validity of the Lane-Fox distribution patents, and take a licence to work under them, paying a royalty to the Lane-Fox Company.

New Pacific Cable Company.—A Reuter's cablegram from Washington, dated Wednesday, says:—Mr. Mitchell introduced a Bill in the Senate on Tuesday afternoon sanctioning the incorporation of a Pacific Cable Company, with a capital of five million dollars, which would work a cable between San Francisco, Hawaii, Samoa and Japan. The Bill provides that the majority of the directors shall be citizens of the United States, and authorises the Treasury to pay the company an annual subsidy of $200,000 for 15 years.

British Insulated Wire Company.—We hear that this company is busily engaged in constructing large works on 10 acres of land communicating with the London and North Western Railway Company's siding at Prescot Station, Lancashire. The building will probably be finished at the end of May this year. The company has sent us some excellent looking samples of its telephone and electric light leads, manufactured under the patents of the Norwich Insulated Wire Company, of New York.

Impending Transformer Litigation.—We understand that the Westinghouse Company has entered an opposition to the extension of the Jablochkoff patent, to which we alluded in a leading article in the REVIEW of the 16th instant.

An Electric Light Accident.—A workman, named Clark, received a shock while repairing an electric lamp at Bath, on Tuesday. He fell to the ground, a distance of 15 feet, and sustained concussion of the brain.

Institution of Electrical Engineers.—The paper which Major-General Webber read last week at the Institution has come to hand so late that we must now leave it over until our next issue.

Lighting at Frankfort-on-the-Maine.—A Frankfort daily paper states that the State Railway Administration proposes to establish a large installation in the Gneisenaustrasse to be worked by steam power. This installation is to replace the plant which lights the railway station, and which was very defective, owing to its being worked by water power from the Maine, the supply of water not being constant.

The City and South London Railway.—The bill for the extension of this railway to Islington has been found to be in compliance with the standing orders.

Electro-Harmonic Society.—Members are reminded of the excellent concert to take place this evening, which we feel sure will draw them and their friends together in large numbers.

Personal.—Mr. W. T. Hunt, who was the first of the four gentlemen who engaged with the *New York Electrical World* when it was founded in 1883 has severed his connection with that paper and purchased a proprietary interest in the *Electrical Age.*

Mr. Drake's Accident.—Mr. Drake has sufficiently recovered from his severe accident to enable him to be conveyed home from the Westminster Hospital, and it is hoped that he will in time thoroughly recover from the effects of his fall.

Coincidence.—The recently paid dividend of the Electric Construction Corporation was at the rate of 6 per cent. on the capital of £500,000—£30,000. The amount to be appropriated out of the present issue of £100,000 Debentures to the repayment of loans secured by temporary debentures is £30,000.

Mine Explosions in France.—The committee appointed by the French Government to investigate the subject of mine explosions of course finds, writes the United States Commercial Agent at St. Etienne, that the primary cause is the igniting of fire damp. After a disquisition as to the probable cause, the commercial agent says that he cannot leave the subject of lighting without mentioning the electric lamp invented lately, and of which a member of the French Academy of Science (Count de Gerson) gave the fullest details in a recent meeting, and produced a specimen which greatly interested that assembly. This lamp is the "Stella," and has been described in a previous number of the REVIEW.

Company Financing.—The *Mechanical World* is beginning to speak out rather strongly on electrical company financing. In referring to the electric lighting of the City our contemporary states:—"There is, however, one thing which seems discreditable, and that is the proposal to transfer the concessions to one, or probably two, limited liability companies. Surely the two contractors are either sufficiently strong financially to carry out the work themselves, or are able to provide any additional money which may be required, privately. New electrical companies of recent date appear to be only launched to bring in large sums to the promoters, and it is to be regretted that in this instance, although the contractors will retain a proportion of the shares and the engineering control in the new company or companies, the same element appears to be present." The *Mechanical World* evidently thinks that the companies with concessions might extend their capital by issuing debentures, but the course adopted is no doubt the best practically.

Terrible Accident to a Telegraph Lineman.—John Reid, a telegraph lineman, residing in High Street, Edinburgh, met with a fearful accident, on Sunday week, which, it is feared, will end fatally. Reid was engaged on the top of a telegraph pole, 50 feet high, at Junction Bridge Railway Station, Leith, transferring wires, when the pole fell down, precipitating him to the ground. He was picked up in an unconscious condition, and conveyed on a stretcher to Leith Hospital, where it was found that, besides internal injuries and a broken leg, the poor fellow had sustained a compound fracture of the skull.

Telephone Accident in Manchester.—While some men employed by the National Telephone Company were engaged in erecting a double standard in Cromford Street, Manchester, the wall to which it was stayed gave way, and knocked down two of the men, one of whom died shortly after admission to the hospital.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Tanning Company, Limited. (Tanning by aid of electricity.)—The annual return of this company, mady up to the 31st ult., was filed on the same day. The nominal capital is £70,000 in £1 shares. 35,140 shares are taken up, and the full amount has been called thereon. The calls paid amount to £33,532 10s., and unpaid to £1,607 10s.

S. Z. de Ferranti, Limited.—The statutory return of this company, made up to the 10th November, was filed on the 24th November. The nominal capital is £100,000 divided into 2,000 perference and 8,000 ordinary shares of £10 each, the whole of which are taken up, and of these 1,993 preference, and 8,000 ordinary shares are considered fully fully paid up. Upon seven preference shares the full amount has been called and paid. Registered Office: St. Benet Chambers, Fenchurch Street.

Bath Electric Light Company, Limited.—The annual return of this company, made up to the 15th inst, was filed on the 21st inst. The nominal capital is £25,000 in £10 shares. Seven shares are taken up, and £2 per share has been called and paid thereon, the paid up capital thus being £14. Registered Office: 2, Northumberland Buildings, Bath.

Birmingham Telegraph Factory, Limited.—The registered office of this company is at 22, Graham Street, Birmingham.

Woodhouse & Rawson Electric Supply Company of Great Britain.—The registered office of this company is changed to 11, Queen Victoria Street.

North Eastern Telephone Company, Limited.—The registered office of this company is situate at 25, Westgate Road, Newcastle-on-Tyne.

Portland Electric Light Company, Limited,—The annual return of this company made up to the 13th inst. was filed on the 23rd inst. The nominal capital is £45,000 in £5 shares. Seven shares are taken up and are fully paid. Registered office, 48, Osnaburgh Street, N.W.

Railway Automatic Electric Light Syndicate, Limited.—The annual return of this company made up to the 13th inst. was filed on the 21st inst. The nominal capital is £10,000 in 400 shares of £25 each. The whole of which are taken up, 200 being considered as fully paid. Upon 200 shares the sum of £14 per share has been called, the calls paid amounting to £2,724, and unpaid to £76.

Electrical Purification Association, Limited.—The annual return of this company made up to November 28th, 1890, was filed on the 1st ult. The nominal capital is £25,000 in £1 shares. 14,825 shares are taken up, 5,000 of which are considered fully paid. Upon 98,255 the full amount has been called, the total of the calls paid being £9,725, and unpaid £100. Registered office, 22, Great George Street, Westminster.

CITY NOTES.

The Beginning of the End.—At the meeting of the Foreign Elmore Company yesterday to prevent an amendment to postpone the passing of the accounts for further consideration being passed, the directors had to vote, and then, amid cries of "officials," the numbers for the amendment came out 17 as against 21, or only five short of the number required to carry it. We are sorry that the meeting was held just as we were going to press and that we must therefore defer the full report until next week, but the chief points brought out at the meeting will be found appended.

Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited.

The directors' report to the shareholders states "That in the latter part of 1890, the board disposed of the company's French patents to Elmore's French Patent Copper Depositing Company, Limited, and the Austro-Hungarian and German patents to Elmore's Austro-Hungarian Patent Copper Depositing Company, Limited, and an amount of £30,000 has been written off purchase of patents' account in respect of these sales.

"The French Company have secured the services of Mons. Eugène Secrétan, formerly manager of the Société des Metaux, as their general manager in France, and are very rapidly pushing on with their arrangements for the erection of their works at Dives, near Havre, which, M. Secrétan reports, will be at work by the 1st July next. The Austro-Hungarian Company are also actively engaged in making their arrangements for the advancement of that company's operations, in both Austria and Germany.

"In order to cope with the large scale upon which the French company propose to manufacture, it was necessary to increase their working capital, and their directors agreed with this company that they should take up 6 per cent. debenture stock to the amount of £50,000, repayable in three years, with 5 per cent. premium. As large holders of shares in the French company, it was to the interest of this company to make such advance.

"At a recent meeting of the shareholders of the French company, it was considered that this debenture stock should be offered to the shareholders of the French company, as the feeling of the shareholders was that they should have an opportunity of subscribing for a portion of the said stock, and negotiations have taken place between the French company and this company, with the view to your directors agreeing to comply with the wishes of the shareholders, and accordingly a circular will shortly be issued to them in fulfilment of their wish. Your directors, however, have stipulated that their own shareholders should also have an opportunity of subscribing for this stock. Accordingly a form of application will be sent to you at the same time as they are issued to the shareholders in the French company.

"The company's balance sheet and profit and loss account for the period embraced between the date of the company's formation on June 6th, 1889, and March 31st, 1890, were submitted and passed on December 29th. 1890, but were not generally circulated to the shareholders. The board now have the pleasure to append hereto these accounts, together with the balance sheet and profit and loss account for the nine months ending December 31st, 1890, showing a net profit at that date of £222,772 19s. 11d., after writing off the sum at which the patents sold stood in the account.

"Out of this sum, the directors on the 8th of December last, in respect of such profits, paid an interim dividend of £4 per priority share (less income tax), and they now have pleasure in recommending a further dividend of £1 per priority share, which will thus absorb £75,000.

"The balance left in hand is represented principally by debenture stock and shares of Elmore's French Patent Copper Depositing Company, Limited, and Elmore's Austro-Hungarian Patent Copper Depositing Company, Limited. which in our balance sheet are valued at par (the debentures at £100, and the shares at £2 each), whereas the shares stand at a higher price in the market, and are expected to rise considerably as the works advance.

"The directors propose, with reference to the balance, either to realise these shares by means of the Trust Company, which the shareholders have already been informed of, or to distribute them as further dividend to the shareholders holding the priority and the founders' shares.

"These will be entitled, in accordance with the articles of association, to the following division, viz.: the priority shares to a further £5 per share, which would amount to £75,000, and one-fourth of the surplus then left, the founders' shares taking the remaining three-fourths; or the directors, if the shareholders so desire, can retain the shares and divide the dividends as received by them.

"This company holds a large number of patents for working the Elmore process in various foreign countries, such as the United States, Belgium, Italy, Spain, Portugal, Sweden and Norway, Australia, Tasmania, New Zealand, India, Argentine Republic, Canada, Cape of Good Hope, Chili, Denmark, Switzerland, Turkey, and others, and as the merits of the invention have now been generally recognised, your directors anticipate being able to dispose of several more patents in the course of the present year. The arrangements with regard to the American Patents are so far advanced that a company is in process of being formed, and is expected to be brought out at an early date.

"Under the provisions of the company's articles, a third of the members of the board retire at the general meeting, to be held on the 29th inst., viz.:—Mr. William Elmore, Mr. George Holmes and John Macfarlan, and these gentlemen being eligible offer themselves for re-election.

"The accountants, Messrs. Pixley & Co, offer themselves for re-election as auditors of the company, and the board recommend a payment of 25 guineas as their remuneration for the nine months ending 31st December last.

"The directors congratulate the shareholders on the progress already made in developing the Elmore process, and the encouraging outlook for the results to be obtained therefrom. The favourable reports on the invention recently given by both English and French experts have satisfied the board that the opinion they originally formed as to the Elmore process being of very great value gives every indication of being realised. The directors, therefore, look for a continuous increase in the value of your property,"

The meeting of the company was held yesterday at the Cannon Street Hotel, Sir J. Morris in the chair.

The Chairman said he could congratulate shareholders on the realisation of the hopes held out by him at the last meeting of the company in October. He stated then that the directors had the fullest confidence in the value of the Elmore patents, and had declined to negotiate for the sale of foreign patents until the English company proved a success, which he considered had been fully proved. As shareholders were aware they had disposed of the patents for France, Austria, Hungary and Germany, and had acquireda considerable sum with which they paid £4 per share to the proprietary shareholders, and it was proposed now to pay another pound. They trusted to dispose of patents to two or three countries during the year and thus obtain a further sum of money to enable them to pay considerable dividends. The chairman then referred to the debentures taken over from the French Company.

After an amendment proposed by Mr. Hoster as to the distribution of profits, which was ruled by the solicitor as illegal,

A SHAREHOLDER asked how it was the directors failed to account, roughly, for £100,000 difference between the net and the gross profits.

The CHAIRMAN considered that after the work performed by the directorate during the year, it was rather hard to be taken to task on the subject of the report. The real explanation of the deficit was that £100,000 was spent in underwriting and the promotion of the other companies.

An amendment to postpone the accounts for further consideration was negatived by 21 to 17.

A full report will appear in our next issue.

Elmore's Austro-Hungarian Patent Copper Depositing Company, Limited.

ON Friday last the first general meeting of the above-named company was held at Cannon Street Hotel. The chairman of the company, Sir John Morris, was not able to be present, the decease of a relative having called him away. Mr. JAMES ROCK presided in his place.

The SECRETARY read the notice convening the meeting, and the three resolutions which were subsequently to be submitted to it, and which were as follow:—

1. That the name of the company be changed to "Elmore's Austro-Hungarian Metal Company, Limited."

2. That article 84 of the Company's Articles of Association be rescinded, and that the following new article be inserted in lieu thereof:—"The qualification of a director shall be the holding of 200 shares of the company. A first director may act before acquiring his qualification, but shall in any case acquire the same within one month from his appointment; and unless he shall do so he shall be deemed to have agreed to take his said shares from the company, and the same shall be forthwith allotted to him accordingly.

3. That Article 107 of the Company's Articles of Association be altered by omitting the following words at the commencement thereof: "Notwithstanding anything in the last preceding article contained or any rule of law or equity to the contrary."

Mr. JAMES ROCK having explained the circumstances which had placed him in the chair, there was no need, he said, for him to explain what a statutory meeting was, but he would just say what it was not; it was not a meeting for business. Usually the shareholders and directors met face to face, the chairman made some statements, bowed, and the meeting was at an end. To-day, however, the directors had thought it wise to utilise the meeting by placing before it the resolutions that had just been read. He would, however, defer any reference to them till he had said a few words as to what the directors had done since they were entrusted with the management of affairs. The company was registered four months ago, and the board had met very frequently to get through the legal formalities necessary; for, of course, it was much easier to start a company in England to do business here than to start one abroad, especially when the business was based on a patent. They had had to go through formalities on account of the patent, and also to get a license to trade in the country, However, so far as England was concerned, everything was done, and all was going on well in Austria, but other difficulties arose, owing to Austro-Hungary being a double country; there were consequently double formalities to go through which greatly delayed them in getting through the earliest stages of the matter. They had not meanwhile been idle in getting on with the business. Their general manager and Mr. Stepney Rawson had been in Austria inspecting a number of sites for works, and under their advice the directors had decided on a remarkably good situation alike for raw material, transport, cheapness of fuel, and abundance of labour. They had the option of purchase. They had also a portion of their works being carried on through existing industrial agencies. With regard to Germany, they were aware that not long after they had started the Austro-Hungarian Elmore Company they had an opportunity of acquiring the German wire patent and other rights in that country. This was a great piece of good fortune, for Germany offered a larger field than Austro-Hungary, and he hoped that they would make even better progress there. At present they were in close negotiation—indeed, almost at the completion of negotiations—for a very large and suitable manufactory built for factory purposes on an exceedingly good site, alike for transport and other purposes. It was a new building, a portion of it not being quite finished, and had water-power of 550 H.P., the turbines being new, and all perfectly fitted with the gear belonging to them. Indeed, it had everything necessary for their purposes, and Mr. Elmore was now in Germany completing arrangements, and obtaining the necessary plant, dynamos, and other machinery for the Elmore process. They had not, as the French company had, M. Secretan to assist them. They had no Hercules to call on, like the wagoner in the old fable; but they would put their own shoulders to the wheel, and if they did not beat the French company in the time of getting to work, they would, at any rate, run a good second. With regard to the process itself as was known to them, it was the manufacture of copper articles, taking them from the raw material up to the finished stage by an almost automatic process. He had seen it himself, and he was sure that a more beautiful process was never invented. Dr. John Hopkinson had written in the strongest terms, and they had the more practical testimony of M. Seeretan, against whose abilities in regard to copper manufacture no one could say a word. He wanted to say something as to the position of the company in regard to finance. They had allotted fifty thousand shares, and they were very largely paid up, better than could have been expected from the difficult financial times they had been passing through. The shares were allotted to about five hundred and eighty shareholders. Turning to the resolutions, the chairman said that the first one related to the alteration of the name of the company. This alteration could not be actually made unless it was approved by the board of Trade and the directors asked the shareholders to give them the power to make the alteration and leave to them the time when the name should be altered. He then moved the first resolution which was seconded by Mr. McFarlane and carried.

Continuing his speech the Chairman explained that the object of the other two resolutions was to obtain a special settlement on the Stock Exchange. He then moved these resolutions, they were seconded and carried, and the usual vote of thanks brought the meeting to a close.

Anglo-American Telegraph Company, Limited.

ACCORDING to the last published report of the directors the total receipts from July 1st to December 31st, 1890, including the balance of £2,793 18s. 4d. brought forward from the last account, are estimated at £161,986 14s. 2d. This amount, however, is subject to revision, as the law suit between this company and the Paris and New York Telegraph Company is still pending before the Council of State.

The traffic receipts show an increase of £3,027, as compared with the corresponding period of last year.

The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £56.142 6s. 11d.

Interim dividends of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, were paid on November 1st last, absorbing £52,500, leaving a balance of £53,344 7s. 3d., out of which the directors recommend the proprietors to declare final dividends of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, amounting to £52,500, making a total distribution for the year ended December 31st, 1890, of £2 17s. 6d. per cent. on the ordinary stock, and £5 15s. per cent. on the preferred stock, leaving £844 7s. 3d. to be carried forward to the next account.

The company's repairing ss. *Minia* has been engaged during the past half-year in the repair of the Northern Placentia cable and was previously chartered to the Direct United States Cable Company.

The vessel has been undergoing necessary repairs, and not being available when a serious fault appeared in the Brest-St. Pierre cable, near Brest, the directors took advantage of the Eastern Telegraph Company's ss. *Mirror* being in the neighbourhood to obtain her services, and the repair was promptly and satisfactorily effected by that ship.

The company's cables and land lines are in good working order.

The directors greatly regret to announce the resignation through failing health of their valued colleague, Viscount Monck, who has occupied the position of chairman, with great advantage to the company, since 1873.

The board unanimously elected the Marquis of Tweeddale as chairman and Mr. F. A. Bevan as deputy-chairman.

The vacancy on the direction created by the retirement of Lord Monck, has been filled by the appointment by the Board of Sir Albert J. Leppoc Cappel, K.C.I.E., formerly Director General of Telegraphs in India.

In accordance with the articles of association, two directors of the Company, the Marquis of Tweeddale and Cyrus W. Field, Esq., retire at this meeting, and, being eligible, offer themselves for re-election.

Mr. Joshua Dean and Mr. John Gane, F.C.A., the auditors, retire, and offer themselves for re-election.

The Electricity Supply Company for Spain, Limited.—This company invite applications to Messrs. Martin & Co. for an issue of £75,000 in 6 per cent. mortgage debentures at 98, which will be secured by a first mortgage (in favour of trustees) on the company's freehold land, buildings and machinery, and by a floating charge on all the company's other property.

Western Union Telegraph Company.—The numbers are announced of seven bonds of £200 each and six bonds of £100 each of the 6 per cent. sterling loan, to be paid off on and after 2nd March next, at the office of Messrs. Morton, Rose & Co., Bartholomew Lane, E.C.

Woodhouse and Rawson.—An extraordinary general meeting of Woodhouse and Rawson United, Limited, was held this week at 88, Queen Victoria Street, E.C., at which a resolution passed at an extraordinary general meeting of the company, held on the 9th day of January, and reported in our issue of January 16th, for the creation of fresh capital was confirmed.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended January 23rd, 1891, amounted to £6,367.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 23rd, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £5,195.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (January 22).	Closing Quotation. (Jan. 29).	Business done during week ending January 29, 1891.	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	98 —101	98 —101	99⅞	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	48½— 49½	...	...
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	85 — 86	85½— 86½	86	85
2,809,310*l*	Do. do. Deferred	Stock	13 — 13½	12½— 13	12¾	12⅝
130,000	Brazilian Submarine Telegraph, Limited	10	11¼— 11¾	11½— 12	11¾	11½
84,500*l*	Do. do. 5 p. c. Bonds	100	102 —105	102 —105	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	102 —106	102 —106	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2¼— 2½	2¼— 2½	2 7/16	2 5/16
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1½— 2	1½— 2	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	104 —105	104 —105	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5 — 5½	4½	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	17½	17¼
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3½— 4	3¾	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜xd	10⅛— 10⅜	10 5/16	10¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅛— 14⅜xd	14 — 14¼	14¼	14
70,000	Do. 6 p. c. Preference	10	14¾— 15¼xd	14¾— 15¼	15	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	105 —108	105 —108	108½	107
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 14⅝xd	14⅜— 14⅝	14¾	14 7/16
320,000*l*	Do. 6 p. c. Debentures, repay February, 1891	100	101 —103	101 —103	...	...
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	104	...
145,300*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	104	...
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	100 —102	100 —102	102	101¾
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6¾— 7¼	6¾— 7¼	7⅛	6¾
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4¾— 5¼	4¾— 5¼	5	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3¾— 4¼	3¾— 4¼	4¼	3 15/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¾— 2¼	1¾— 2¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9 — 9¼	9 — 9¼xd	9¼	9
180,042	Do. do. 6 p. c. Preference	10	14¾— 15	14⅞— 15⅛	15	14¾
150,000	Great Northern Tel. Company of Copenhagen	10	16½— 17	16¾— 17¼	16⅞	16¾
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105—108	105 —108	106	...
9,384*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10½— 11½	10½— 11½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,800	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19¼	19
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	35 — 37	35 — 37	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	9¼— 9¾ xd	9¼— 9¾	9⅜	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾ xd	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£8 paid)	10	7¾— 8¼	7½— 8	8¼	8 3/16
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅝— 4⅞	4 15/16	4 9/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12½— 13	12⅞	12 13/16
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10¼— 10¾	10 — 10½	10 7/16	10⅜
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000	Reuter's Limited	8	8½— 9	8½— 9	8⅝	...
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ⅜	⅛— ⅜	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2¾— 3¼	2¾— 3¼	...	...
3,381	Submarine Cables Trust	Cert.	112 —115	112 —115	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4 13/16	...
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	...	...
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —103	101 —103	...	...
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 95	90 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	100	98½
30,000	West Coast of America Telegraph, Limited	10	2 — 4	2 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	95 —100	95 —100	98	...
64,174	Western and Brazilian Telegraph, Limited	15	11¼— 11¾	11¼— 11¾	11⅝	11¼
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	6⅞	6 9/16
27,873	Do. do. do. 5 p. c. Deferred	7½	5 — 5½	4¾— 5¼	5	...
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	104 —107	105¼	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	104 —107	106	...
88,321	West India and Panama Telegraph, Limited	10	2⅝— 2⅞	2⅝— 2⅞	2⅞	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11¼— 11¾	11¼— 11¾	11¾	11⅜
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11 — 12	11 — 12	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	99 —103	99 —103	...	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	3½— 4	3½— 4	3⅞	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium), 2½—2⅝.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 1¼—1⅜.—Manchester Edison and Swan Company, £9 (£1 paid) 11s.—13s.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2⅜—2⅝.—Preference, 4⅜—4⅝.

BANK RATE OF DISCOUNT.—3 per cent. (29th January, 1891).

INTERRUPTIONS AND REPAIRS TO SUBMARINE CABLES DURING 1890.

Name of Company.	Section.	Date of interruption.	When repaired.	Duration of each interruption (days).	Total days section interrupted.	Number of interruptions 1888, '89, '90.	Number of days interrupted in 1888, '89, '90.
Black Sea Telegraph Co.	Odessa—Constantinople ...	22 Dec., '90	1 Jan., '91	10	10	3	86
	Constantinople—Dardanelles ...	31 Dec.	...	...	...	...	...
Central and South American Telegraph Co.	Buenaventura—Santa Elena ...	30 Aug.	7 Sept.	8	8	...	...
	Salina Cruz—Libertad ...	25 Nov.	4 Dec.	10	10	...	...
Eastern Telegraph Co.	Porthcurno—Vigo	1 Nov.	20 Nov.	19	19	...	...
	Vigo—Lisbon	1 Nov.	17 Nov.	16	16	...	...
	Suakim—Djedda	8 Jan.	13 Jan.	5	5	...	...
	Suakim—Suez	9 May	9 July	61	...	4	97
	" "	12 Sept.	13 Sept.	1	62	...	...
	Suakim—Perim	9 May	29 July	81	...	4	204
	" "	12 Sept.	10 Dec.	89	170	...	...
Eastern Extension, Australasia, and China Telegraph Company	Aden—Zanzibar	8 Jan.	9 Jan.	1	1	...	...
	Rangoon—Penang	9 May	14 May	5	5	...	...
	Madras—Penang	13 May	21 May	8	8	...	...
	Banjoewangie—Port Darwin ...	11 July	20 July	9	...	5	56
	" " ...	11 July	26 July	15	24	...	...
	Banjoewangie—Roebuck Bay ...	11 July	2 Aug.	22	22	...	...
	Hong-Kong—Foochow	21 July	26 July	5	5	...	...
	Cape St. Jacques—Thuanan ...	21 Oct.	27 Oct.	6	6	...	...
Eastern and South African Telegraph Company	Benguela—Mossamedes... ...	16 June	2 July	16	16	...	...
	Lourenço Marquez—Durban ...	15 Oct.	16 Oct.	1	1	...	...
	LourençoMarquez—Mozambique	11 Nov.	11 Nov.	½	...	...	...
	" "	18 Nov.	19 Nov.	1	1½	...	...
	Zanzibar—Mombassa	20 Dec.	30 Dec.	10	10	...	...
Great Northern Telegraph Company	Fanœ—Calais	6 Jan.	8 Feb.	33	...	...	...
	" "	28 Feb.	12 March	12	45	...	...
	Amoy—Shanghai	21 July	3 Aug.	13	13	...	...
International Ocean Telegraph Company	Punta Rassa—Key West ...	18 Jan.	24 Jan.	6	6	4	34
Western and Brazilian Telegraph Company	Para—Maranham	27 Dec., '89	7 Jan., '90	11	...	7	102
	" "	9 Jan.	16 Jan.	7	...	...	...
	" "	24 July	21 Aug.	28	46	...	...
	Maranham—Ceara	29 April	20 May	21	21	3	69
	Ceara—Pernambuco	8 April	13 April	5	5	...	...
	Rio de Janeiro—Santos. ...	5 April	7 April	2	...	3	14
	" "	26 Dec.	29 Dec.	3	5	...	...
	Santos—Santa Catarina ...	12 March	13 March	1	1	...	...
	Sta. Catarina—Rio Grande do Sul	16 May	18 May	2	2	...	...
	Rio Grande do Sul—Monte Video	5 May	9 May	4	4	4	38
West Coast of America Telegraph Company	Chorrillos—Mollendo	21 Feb.	24 Feb.	3	...	4	23
	" "	15 March	20 March	5	8	...	...
West India and Panama Telegraph Company	Jamaica—Colon	15 July	4 Sept.	51	...	3	135
	Trinidad—Demerara	18 Nov.	8 Dec.	20	...	7	82
	Jamaica—Puerto Rico	15 Dec.	23 Dec.	5	...	...	...
	Jamaica—Santa Cruz	15 Dec.	...	...	...	...	...

AN OXFORD PROFESSOR'S VIEWS IN THE SEVENTEENTH CENTURY ON THE NATURE OF LIGHTNING.

ONE of the most important events of the reign of Charles II. was the incorporation by him, in 1662, of the Royal Society for the Improvement of Natural Knowledge. Ever since its foundation this society has been a nucleus round which has clustered the scientific genius of Great Britain. Previous to the formation of the Royal Society, men sought knowledge through false paths. It was an age of mysticism and alchemy. Theories were formed first and the facts made to fit them; men did not reason from the facts to the theory, but from the theory to the facts. It is little to be wondered at, therefore, that the progress of knowledge was very slow.

The difficulties which lay in the way of the Royal Society can hardly be estimated in these days when the habit of thought is so different. Somehow or other, it managed to bring together those who were in sympathy through their devotion to science and who in their union found strength. By the interchange of their ideas, thought was quickened and the progress of knowledge aided.

The society undertook the publication of original papers, and thus new discoveries were placed on record and preserved from being lost, as had too often happened before. At the periodical meetings of the society these papers were discussed and criticised, and this helped to sift the evidence upon which conclusions were based, while at the same time it promoted much increased accuracy and simplicity of thought and expression.

As the members of the Royal Society became acquainted with each other through the frequent meetings, much intercourse followed and they began to correspond with each other upon matters of interest. Many of these letters have been fortunately preserved, and in some instances are curious examples of the habit of thought with which natural phenomena were then regarded.

Uncertainty and doubt were perhaps amongst the chief characteristics of the minds of scientific men in the latter part of the seventeenth century. These were good signs. Slowly, but surely, faith was being lost in the so-called truth of transmutation. But alchemy and mysticism died hard, and ere they were finally crushed, offshoots from them, such as the phlogistic theory, cast a baleful hindrance in the way of scientific progress.

At the end of the seventeenth century, amongst the foremost men of science stood Dr. Wallis and Dr. Sloane. The latter is more generally known by his title Sir Hans Sloane, Bart. He was a physician and naturalist, and was born in 1660. His library and collection, which were purchased by Parliament for £20,000, are now in the British Museum. Amongst other works, he published an account of a "Voyage to the Islands Madeira, Barbados Nieves, St. Christophers, and Jamaica."

Dr. Wallis was a mathematician and divine who wrote many treatises upon mathematics, which subject he professed at Oxford.

There is still preserved a very curious letter from Dr. Wallis to Dr. Sloane: the latter was then, comparatively speaking, a young man, and he did not get his baronetcy until 1716, a few years before he became President of the Royal Society.

This letter contains Dr. Wallis's views concerning the "generation of thunder and lightning," and is dated from Oxford, July 26th, 1697. It appears that Mr. Edmund Halley, the astronomer, and friend of Newton, had published a thesis upon the origin of hail and lightning, which had given rise to much comment amongst the Fellows of the Royal Society. Referring to this work, Dr. Wallis says in his letter to Dr. Sloane:—

"If I may interpose my opinion, you may take it thus:—

"Thunder and lightning are so very like the effects of fired gun-powder, that we may reasonably judge them to proceed from like causes. The violent explosion of gun-powder, attended with the noise and flash, is so like that of thunder and lightning as if they differed only as natural and artificial; as if thunder and lightning were a kind of natural gun-powder, and this a kind of artificial thunder and lightning.

"Now the principal ingredients in gun-powder are nitre and sulphur (the admixture of charcole being chiefly to keep the parts separate for the better kindling of it), so that if we suppose in the air a convenient mixture of nitrous and sulphorous vapours and these by accident to take fire; such explosion may well follow, with such noise and light, as in the firing of gun-powder, and being once kindled, it will run on from place to place as the vapour leads it, as in a train of gun-powder, with like effect.

"This explosion, if high in the air, and far from us, will do no mischief, or not considerable; like a parcel of gun-powder fired in the open air, where is nothing near to be hurt by it; but if near to us (or among us) it may kill men or cattle, tear trees, fire gun-powder, break houses, or the like; as gun-powder would do in like circumstances. Now this nearness or farness may be estimated by the distance of time between seeing the flash of lightning and hearing the noise of the thunder. For though in their generation they be simultaneous; yet (light moving faster than sound) they come to us successively. I have observed that commonly the noise is about seven or eight seconds after the flash (that is about half a quarter of a minute); but sometimes much sooner—in a second or two, or less than so, and almost immediately upon the flash. And at such time the explosion must needs be very near us, or even amongst us . . . .

"Now that there is in lightning a sulphorous vapour, is manifest from the sulphorous smell which attends it, especially when hurt is done; and even when no hurt is done, from the lighting itself, more or less discernable. And a sultry heat in the air is commonly a fore-runner of lightning soon after.

"And that there is also a nitrous vapour with it, we may reasonably judge, because we do not know of any body so liable to a suddain and violent explosion.

"Now these materials being admitted, it remains to be considered how they may be kindled in order to such explosion. As to which, I have been told from chymists (though I have not seen it tried) that a mixture of sulphur, filings of steel, with the admission of a little water, will not only cause a great effervescence, but will of itself break forth into an actual fire.

"So there wants only some chalybeat or vitriolick vapour (or somewhat equivalent) to produce the whole effect (there being no want of aqueous matter in the clouds).

"And there is no doubt but that amongst the various *effluvia* from the earth, there may be copious supplies of matter for such mixtures."

That Safe Illuminant.—A gas explosion took place last week in the First United Presbyterian Church at Kelso. By the force of the explosion two of the three windows lighting the session house were blown bodily out, the zinc framework being also twisted out of shape. The church officer had entered the session house with a lighted taper with a view of finding a suspected leak, and he found it.

ELECTRIC LIGHTING AT THE GENERAL POST OFFICE.

THROUGH the courtesy of Mr. Preece we have recently had the opportunity of inspecting the electric lighting of the General Post Office East, *i.e.*, St. Martin's-le-Grand, an edifice full of interest and industry, combined with great regularity. From this building mails are received and despatched to all parts of the world in the most systematic order without the least apparent confusion. Indeed, when we consider the fact that the normal number of postal missives of all kinds which pass through the office daily in 24 hours, reach 3,300,000, and that a staff including Overseers, Sorters, Mail Officers, Lobby Officers, Mail Messengers, Postmen, Porters, Auxiliaries on alternative evenings, Cleansing Staff, Messengers, and Doorkeepers, number 3,145, nothing but high praise is due to the able Controller, Mr. R. C. Tombs, Assistant Controller, Mr. J. C. Badcock, and their worthy Officers for their indefatigable energy in executing the arduous duties of H.M. Post Office to satisfy the wants of all classes of mankind.

Our readers will doubtless be interested if we place before them some interesting particulars relating to electric lighting which has been so skillfully directed by Mr. W. H. Preece and his able assistant, Mr. I. Probert, the electric light superintendent.

The approximate dimensions of the main building are 370 feet by 124 feet.

Area of basement ...	5,300 yards.
" ground floor...	4,300 "
" first floor ...	2,500 "
" second floor ...	3,000 "

The height of the building from the street level is 50 feet, and the basement is 12 feet high. The mail-cart yards at the the north and south ends and along the east side of the edifice occupy a total area of 3,600 yards.

Something like 2,600 gas burners were, prior to the introduction of the electric light, in daily use within the building. The depressing effects of the gas, supplemented by the carbonic acid exhalations from the numerous officers engaged, often produced much sickness and langour. These gas lights will be replaced by about 1,800 incandescent lamps, and 60 Brockie-Pell, 10 ampère, 32 hour arc lamps, exclusive of 16 similar arc lamps outside the building. From the nature of the sorting duties, arrangement of tables, and peculiarity of the building, to satisfy the conditions of efficient yet economical lighting, and, so far as practicable, to guard against dangerous heating, tampering, or total extinction of light, considerable thought and care has been expended upon this installation. It will be evident to our readers that when hundreds of letters inscribed with manifold variations of style, have to be sorted in a short time, there must be no permanent nor intermittent shadow, nor any dazzling effect on the work from any source whatever. The sorting tables and boxes are arranged in rows, with aisles between, and also along the walls, and their height varies from 5 feet to 6 feet 6 inches. Hence to obliterate shadow, the arc lamps have been hung 14 feet from the ground, and so placed that at an angle of 45°, the rays of light from each intersect well above the tables and thereby diffuse an even light over all parts of the room. Where rows of sorting tables occupy the open space between the walls, and are lighted with incandescent lamps, the plan of illuminating the tables is to place the lamps zigzag at such a height over the table that the sorting officer does not get the glare of the light in his eyes, and to distribute the light on both sides of a central frame, which divides the one side of the table from the other, as the clerks sit or stand face to face. These lamps are fed from ceiling roses through flexible cords, but to prevent swinging from currents of air, to give rigidity, and to enable each officer to turn his lamps on or off at will, the lampholder is clamped by a clip to a neat and stout metal standard securely mounted upon the top of the central frame of the tables.

Before setting out the circuit arrangements we may state that everything is in sight, and all the fuses out of reach to unauthorised persons, but easily got at with a light ladder by the electric light attendants.

The size of the engine room is 64 feet × 26 feet, and of the boiler house 74 feet × 40 feet. They are situated immediately below the yard, at the north end of the building, and the one is separated from the other by a partition wall in which two wide glazed doors, one at each end of the room, give access to either room and permit of machinery being passed from one to the other. Every provision will be made to light the three G.P.O's. east, west, and north, from this centre. The boiler house now contains three Davy, Paxman and Company's locomotive boilers (to which three more will be added in the course of time). They stand side by side in the centre, and the power of each is equal to the full load of two Willans and Robinson's 80 I.H.P. engines. A Porter-Clark water softening apparatus comprising water motor, mixing tank, water softening tank, and filter press, occupy one corner. Adjoining these is a large reserve water tank capable of holding enough water to maintain ample boiler feed for about five hours if four of the above engines be working at full load. A Worthington steam pump close by draws the filtered water from the reserve tank and passes it into a water heater, thence to either or all boilers as required. A large drain pit receives the waste water from several channels in the boiler and engine rooms, and empties itself into a large sump from which it is ejected by jetometers into a tank at a suitable elevation above the street drain into which the water ultimately flows. This unavoidable circumstance arises from the boiler floor being 4 feet below the main sewer. In front of the boilers are coal bunkers, and at the extreme north end of the house is a skylight which can be quickly raised to permit of even a boiler being got into or out of the building. The smoke from the furnaces descends through cast iron downtakes into a flue 119″ × 5′ 9″ × 3′ 6″, and ascends through a shaft 113′ × 5′ 6″ × 3′ 6″. A 9-inch cast iron exhaust pipe runs through part of the flue to the shaft and there joins an earthenware pipe, of the same diameter, which extends the exhaust to the top of the shaft. When the extra boilers arrive, a second water heater and independent exhaust pipe will be provided. All the steam pipes (Willans and Sankey's screw socket patent), feed water service, and feed pump are being duplicated, and provision is being made to shut off either boiler or engine as desired.

In the engine room four Willans G G (80 I.H.P.) engines, coupled direct to Elwell-Parker 110 volt compound-wound dynamo machines of 48 unit capacity, are at work. Two of Willans' I.I. 200 I.H.P. type engines, and Parker's 130 kilos capacity dynamos will probably be added this year. All the engines will be in line, with about 3 feet space between each set. An exhaust pipe and drain channel traverses the length of the room on the engine side, and a brick culvert runs parallel with it at the dynamo end of the bed-plates. Caulked wrought iron hooks are fitted into the brickwork of the culvert on each side, at suitable distances apart, and carry glazed earthenware rings through which 61/12's cable of Silvertown and Henley's manufacture pass from each dynamo to the large distributing switchboard at the south extremity of the room. From this board cables radiate to the several floors of the building, and to the G.P.O. West, on the opposite side of Aldersgate Street, and will when the G.P.O. North is finished, communicate with it also. Twelve 8-way switches are arranged in two rows of six, one above the other. The top switches are positive, and those below, negative. Their form is a central base plate with eight clips fixed at an equal distance from one another, and at right angles to the base plate. Surrounding the base plate are eight independent metal segments each of which carries a lever, consisting of a metal bar at right angles to a handle. This works on a fulcrum, from the pillar of which a clip projects immediately in front of a corresponding clip upon the base plate. All are mounted upon a specially prepared and enamelled slate base, through which the metal pillars pass, and which are secured at the back by faced-up nuts of ample area. On these, massive thimbles with 61/12's cables "sweated" therein, are made to lie perfectly flat on the large nuts, and the whole bolted up tightly between washers. Each base plate communicates with its respective dynamo cable, and the encircling segments with their relative floors of the building, and with the G.P.O. West. Clearly engraved bone tablets indicate the destination of each cable from the segments, and a bold figure on the centre plate marks the number of the dynamo. The slate bases are let into wood frames, and the six pairs are visible through glass doors. Above each pair of 8-way switches is a 600 ampèremeter on a separate slate base, held in a separate frame, and inclosed by a glass door. From the back of the distributing board to a wall behind is 4′ 6″ The incoming cables turn from the wall under a platform raised 18 inches above the floor-level, and then rise to their proper segments on the switches. Massive copper bars, well taped and shellaced, connect similar segments representing floors, and divide the six pairs of switches into two distinct circuits, called 1 and 2, in such a manner that dynamos, 1, 3, or 5, can be, singly or collectively, made to feed circuit No. 1, while dynamo 2, 4, or 6, can, in like manner, be put on circuit No. 2. For parallel working each machine is now being furnished with the necessary apppliances to ensure safe and reliable work. Before leaving the engine room we may add that the officer in charge will be enabled to see at a glance the potential at the dynamo terminals, the potential on each lamp circuit, the current each dynamo is giving, and the speed of the engine. An engine-fitter's shop, equipped with tools, is located there; standard testing instruments, and other necessary appliances for calibrating ammeters and voltmeters, or whatever the department desires, also an arc lamp rack for adjusting and examining arc lamps will shortly be in use.

The installation consists of two distinct circuits, and the lamps in all parts of the building are alternated on these two circuits. On each floor, and about the middle of its length, is a distributing board, which separately communicates with the main engine room switchboard just described. By this means the fall of potential for the whole length of the building is halved, and more equally obtained.

The floors are divided into sections; for example, there are two sections in the basement, five sections on the ground floor, two sections on the first floor, and four sections on the second floor; but as each of these sections comprises two circuits, the actual number on each floor is doubled. Each half section is under the control of a single pole switch, and it also has in circuit an "Interchangeable Dynamo Switch." The function of the latter is to transfer the whole or part of the energy from No. 1 to No. 2 circuit, or *vice versâ*, should there be any need for relieving either circuit, or for supplying all or any of the sections from one of the two dynamo circuits.

Two ammeters above these switches show the current in each circuit on the particular floor. By aid of the main ammeters in the engine room the attendant can see the current produced by either dynamo, and by the circuit ammeters on the respective floors he has an indication of the current going to each of the two circuits. Underneath the switches is a cupboard containing the fireproof positive and negative fuse chambers, which are mounted upon a slate base. These are really independent cupboards, divided into as many compartments as there are half sections on the floor lighted, and each group is enclosed by a door with a glass front. They consist of wood frames fastened to the slate base and are lined with slate. The bottom piece of slate which divides the compartment is made to slope from the glass front to the slate back to prevent any hot particles of a fuse rolling against the glass and breaking it. The group of positive fuse chambers are separated from their corresponding negative chambers. The complete switch and fuse chamber cupboards are fitted into a wood structure, and each are under lock and key. A space of about 2 feet deep and of the same height and width as the distributing board, locked, and lighted by electricity, allows the connections to be easily inspected by the electric light officers, and alterations made if necessary.

The main and submain cable casings are fixed on the walls and other appropriate supports against the ceiling, and the lamp leads are teed off alternately throughout the various rooms. Both the branch fuses and the single lamp fuses in fireproof boxes are fitted upon their respective casings as close to the main cables as possible, and, as before stated, while being in sight are out of reach to unauthorised persons. In this way the entire installation is being carried out—everything visible, safe, and sound. The ground and first floors and part of the basement are already lighted by electricity, and the remainder is in an advanced stage of completion.

Edison-Swan 105-volt glow lamps are employed with Edison key socket holders, and a goodly number of "Cycle" switches, as manufactured by the General Electric Company, are also in use where key sockets cannot be adopted.

The Brockie-Pell arc lamps have given great satisfaction. It seems as though the inventors have produced the acme of perfection, for they burn hour after hour, two in series, with marvellous steadiness. During the Christmas week a few ran 38 hours continuously without re-trimming or any attention whatever, while the remainder worked until only about an inch of carbon projecting from their holders remained unconsumed. In the external resistauce Mr. Brockie has introduced an electro-magnetic device, which, by setting up a counter E.M.F. on striking the arcs, causes the lamps to settle down into absolute steadiness in about five seconds, thus effectually doing away with that often objectionable "pumping" when lamps are run in series. The arc lamps are hung at one predetermined height with bare copper strand conductors, from insulators on an iron frame secured to the ceiling. This dispenses with the unsightly "festooning," or heavy balance weights. With a light pair of portable tressles the lamps are easily trimmed, or exchanged when necessary. The outside lamps are supported by strong wrought iron brackets designed and manufactured by Messrs. Lea, Sons & Co., of Shrewsbury.

All the main switches and distributing boards were designed by members of Mr. Preece's staff and made to their drawings, ample and suitable metal being used to bring the conductivity well within the required current density. The main engine-house switchboard, and two smaller boards, were manufactured by the General Electric Company, and the large distributing boards on the ground, first and second floors were made by the Acme Electric Works Company.

The size of the cables and wire have been calculated on two per cent. fall of E.M.F. from the terminals of the dynamos at 110 volts.

As to the benefit already derived from the electric light in the General Post Office, we cannot do better than give a *verbatim* extract from the Controller's report, for the year ended 1890. It is as follows:—

"I must not omit to mention that the electric light, only recently installed, was used on the first and second [this should be *ground* and *first*] floors, with excellent results, the atmospheres in the sorting offices having been much purer than on previous occasions, and the large force massed in the several offices were enabled to work in far greater comfort than heretofore.

"The superintending officers and men were alike loud in its praises. The men certainly performed their duty far better this year than they have ever done before, and the superintending officers attribute that to the fact of the improved atmosphere. There was an absence of that languor and weariness which has been so perceptible at the close of the duty in previous years. I certainly think that the duty was completed an hour earlier than it would have been if the men had been compelled to work again in a poisoned air, and the men worked quicker throughout. During the night [Christmas Eve] double rates of pay prevailed, and I think the new light may be credited with having effected a saving of £400 to £500.

"The benefit of the electric light was especially felt on the outside platforms and in the yards at the General Post Office, where the mail vans are loaded and unloaded. The brilliant light shed by the large arc lamps admitted of the labelling of the bags being easily read. It also materially assisted the work of marshalling vans and in preventing congestion of traffic. As a consequence, the mails were placed in and taken out of the vans—even at the busiest times—with less confusion and with greater celerity than on any former occasion."

This report speaks volumes of good cheer, and we certainly think Mr. R. C. Tombs deserves the highest commendation for his foresight in seeking a purer and better luminant than gas for his men, which has in so short a period proved not only invigorating but decidedly economical. Only those who have actually witnessed the enormous pressure put upon the Postal staff at Christmas time can form any idea of what the strain on the men is like. The climax is reached on the 24th, when all hands are brought on duty at 2 p.m. and work straight on without cessation until 7 or 8 a.m. on the 25th. During the Christmas week no less than 3,216 bags containing 1,158,000 letters were despatched to the Continent. The vast number of Foreign and Colonial letters, social greetings, &c., &c., is something astounding. On perusing the Controller's report, we noticed that one mail carried by the P. and O. Company's steamer *Massilia*, took 622 mail bags, containing about 210,000 letters, &c., to Australia. We further observed an interesting instance of 350,000 *circulars* being transmitted to the Colonies from Dr. Barnardo and 660,000 for inland circulation in the United Kingdom. Another batch of 74,000 circulars was forwarded to the Colonies by the Condy's Fluid Company. Add to these figures the stupendous quantity of missives to India, China, the United States, Canada, in short, to all parts of the globe, and then some idea of the excellent work done at Christmas time at our General Post-Office can be formed. Mr. Tombs states that "the transmission of mails for British Colombia has been greatly accelerated since the extension of the Canadian Pacific Railway to Vancouver in June, 1886. The journey of 6,000 miles by sea and inland is accomplished at the rate of 430 miles per day, so that the Christmas cards posted in London on the 6th December would be at their destination four or five days before the Christmas festival."

Though we have done our best to give our readers a glimpse into St. Martin's-le-Grand, we are convinced that our effort falls far short of the deserving notice it is entitled to receive. However, our attempt will help to show the care and forethought which had to be given in planning the electric lighting of a National Institution so full of valuables, combustible matter, and responsibility, for it is manifest that every practicable precaution against putting the rooms in darkness must be taken. We venture to assert that when the installation is complete, there will be four chances to one against a total collapse under full load.

NEW PATENTS—1890.

20,896. "Improvements in apparatus for regulating electric currents or electric potential." A. Gay and R. Hammond. Dated December 22nd.

20,898. "Improvements in dynamo-electric machines." H. H. Leigh. (Communicated by E. L. Desroziers, France.) Dated December 22nd.

20,927. "Improved insulated circular cut-out box for electric lighting." H. G. Lester. Dated December 23rd.

20,936. "Improvements in electrical signalling apparatus, especially designed for signalling at sea." A. B. Wyckoff. Dated December 23rd. *(Complete.)*

20,940. "Improvements in electrical indicating apparatus for range or location-finding instruments." W. H. Beck. (Communicated by the American Range Finder Company, United States.) Dated December 23rd.

20,986. "Improvements in apparatus for electrically welding and otherwise working metals." H. H. Lake. (Communicated by H. Lemp, United States.) Dated December 23rd. *(Complete.)*

20,992. "Improvements in electric bells." G. H. Jones. Dated December 23rd.

21,017. "Improvements in electric arc lamps." F. Protz and J. Jucker. Dated December 24th.

21,026. "Improvements in electrical attachments for railway switches or points, applicable for ringing an audible signal on the locomotive of a train which is approaching a switch which has been misplaced." A. W. Berne and C. A. Fish. Dated December 24th. *(Complete.)*

21,031. "Improvements in the production of lead plates or electrodes for secondary batteries and the connections, straps or lugs to the same." P. J. Davies. Dated December 24th.

21,032. "Improvements in covering and protecting electric wires and other conductors." W. W. Horn. (Communicated by W. E. Oehrle, United States.) Dated December 24th.

21,043 "Improvements in telegraphic apparatus." S. van Buren Essick. Dated December 24th. *(Complete.)*

21,116. "Improvements in electric arc lamps." A. Gay and R Hammond. Dated December 27th.

21,142. "Improvements in miners' safety lamps, and in the method of lighting the wick thereof by an electric current." O. Y. Rhodes. Dated December 29th. *(Complete.)*

21,143. "Improvements in electric batteries for lighting miners' safety lamps." O. Y. Rhodes. Dated December 29th. *(Complete.)*

21,147. "Improvements in or relating to the insulation of electrical conductors." A. J. Boult. (Communicated by J. B. F. Frédureau, of France.) Dated December 29th.

21,183. "Electric protective and signal systems and apparatus." B. J. B. Mills. (Communicated by C. E. Ongley, United States.) Dated December 30th. *(Complete.)*

21,237. "Improvements in methods of and apparatus for electrically soldering and cementing cans." M. W. Dewey. Dated December 30th. *(Complete.)*

21,254. "Measuring electromotive force and current of electricity in one instrument." Morris Brothers, Limited. Dated December 31st.

1891.

40. "Improvements in electricity meters." G. Hookham. Dated January 1st.

49. "Element and process for producing constant electric currents." W. Wensky. Dated January 1st. *(Complete.)*

83. "Improvements in or relating to electric guest calls or the like." W. P. Thompson. (Communicated by A. Striemer, United States.) Dated January 2nd. *(Complete.)*

100. "Improvements in suspension insulators for electrical conductors and electrical apparatus." W. C. Johnson and S. E. Phillips. Dated January 2nd.

105. "Improvements in lightning arresters for electric conductors." F. Haselwander. Dated January 2nd.

128. "An improved means of and apparatus for regulating automatically the flow of electric currents." J. L. Lee. Dated January 3rd.

176. "Improvements in electric dynamos and motors." W. T. Garnett Dated January 5th.

230. "Improved mechanism for actuating clocks by electricity." F. Schwartz. Dated January 6th.

389. "Improvements in electricity meters." F. Teague. Dated January 8th.

394. "Improvements in electric measuring instruments." W. T. Goolden and S. Evershed. Dated January 8th.

439. "Improvements in torpedoes propelled and steered by electricity." B. J. B. Mills. (Communicated by W. S. Sims, United States.) Dated January 9th.

475. "The absolute silence of telephone, telegraph, and other wires, whether attached to chimneys, buildings, iron standards on roofs, or wooden poles placed in any position." A. E. D. Walters. Dated January 10th.

476. "Wire coupling for electrical conductors." W. E. Banta. Dated January 10th. (Date applied for under Patents Act, 1883, Sec. 103, 11th June, 1890, being date of application in United States.) *(Complete.)*

508. "An improved underground electric conduit." W. H. Munns. (Communicated by H. Young, United States.) Dated January 10th.

536. "Improvements in dynamo-electric generators and motors." C. W. Atkinson and L. B. Atkinson. Dated January 10th. *(Complete.)*

580. "Improvements in and relating to phonographs." F. Mitchell. Dated January 12th.

584. "An improved construction of alternate current dynamo-electric motors." M. Hautin and M. Leblanc. Dated January 12th.

587. "Improvements in or connected with incandescent electric lamps." F. H. P. Berlyn. Dated January 12th.

608. "Improvements in construction of channels for the use of electric conductors in streets." T. Parker. Dated January 13th.

616. "An improved carbon stick or pencil for arc lamps." H. J. Allison. (Communicated by B. B. Ward, United States.) Dated January 13th. *(Complete.)*

617. "Improvements in the construction of electric arc lamps, and appliances used therefor." H. J. Allison. (Communicated by B. B. Ward, United States.) Dated January 13th. *(Complete.)*

641. "Improvements in electric clocks." E. G. Hammer. Dated January 13th. *(Complete)*

647. "Improvements in electrical measuring instruments." H. H. Lake. (Communicated by E. Weston, United States.) Dated January 13th. *(Complete.)*

649. "Improvements in and relating to electric elevators or lifts." H. H. Lake. (Communicated by R. Eickemeyer, United States.) Dated January 13th. *(Complete.)*

667. "Improvements in electrodes for voltaic accumulators." W. P. Thompson. (Communicated by the Hess Electric Storage Battery Company, United States.) Dated January 13th. *(Complete.)*

668. "Improvements in or appertaining to voltaic accumulators." W. P. Thompson. (Communicated by the Hess Electric Storage Battery Company, United States.) Dated January 13th. *(Complete)*

669. "Improvements in electrical cut-outs or safety fuses." J. Puluj. Dated January 13th. *(Complete.)*

743. "Improvements in the application of electricity for mining purposes." W. O. Rooper. Dated January 15th.

884. "Improved apparatus for the production of electricity." C. Wells. Dated January 17th.

887. "Improvements in or relating to the electro chemical extraction of gold, silver, and other precious metals from their ores." The Electrical Inventions Company, Ld., and A. Andreoli. Dated January 17th. *(Complete.)*

899. "Improvement in electric cells or batteries." H. T. Eager and R. P. Milburn. Dated January 17th.

908. "Improvements in insulators for electric wires." F. A. Ross. Dated January 17th. *(Complete.)*

910. "Electro-magnetic mechanism for controlling the transmission of power." A. M. Clark. (Communicated by W. H. Kilbourn, United States. Dated January 17th.

ABSTRACTS
OF PUBLISHED SPECIFICATIONS, 1890.

2,963. "Improvements in the arrangements for and mode of working electric and other railways, in such a way that all may be introduced collectively or singly as auxiliaries to existing railways." R. C. Sayer. Dated February 25th. 1s. 6d. In the case of railways worked entirely by electricity it is intended the whole of the passenger vehicles, or only one as required, shall be provided with a powerful dynamo for propelling them, and when not so used the wheels when in motion shall actuate it and supply a secondary battery, so that when the train has to be stopped the power necessary for thus working the dynamos assists the breaks. The vehicles are provided with both slipper and wheel block breaks, in such a way that a comparatively weak current puts them in work to go on and be taken off instantaneously, but in each case the whole weight of the train, and also its velocity are used to apply the breaks. They are also arranged for the motors to be stopped and the breaks put on by the same and one motion only, but when desired the motors may be stopped without putting on the breaks, and the breaks put on after, 7 claims.

5,645 "Improvements in electric railway apparatus." J. B. Odell. Dated April 14th. 8d. Has for its objects, first, to improve the construction of the conduit, within which will be placed the conductors for current, and within which will travel the contact brushes or wheels that serve to deliver current from the conductors to motors upon the cars. A further object is to improve the construction of arm that carries the contact brushes or wheels, and the means for sustaining and operating said arm from the car. A still further object is to provide improved means whereby the movement communicated from the motor of the car to the driving wheels can be graduated in order to permit the easy starting and stopping of the car without necessarily diminishing the speed of the motor. Also consists in a novel arrangement and connection of the conductors, and means for controlling the passage of current therethrough. 13 claims.

4,670. "Electrical heating devices for forging and analogous machines." O. Imray. (Communicated from abroad by J. J. Gilbert, of New York.) Dated March 25th. 8d. Has for its object a more efficient and rapidly operating means for applying the electric current at the desired time and place.

5,219. "Improvements in electric arc lamps." F. V. Andersen, Dated April 3rd. 8d. Consists in conveying the current to the carbons through the bearings of the pulley and through the supporting cords, in constructing laminated cores for the solenoids so that their magnetism is readily reversed when alternating currents are employed, to substitute for the ordinaty dash pot an electro-magnetic arrangement comprising a copper disc geared to the supporting drum and rotating between the poles of an electro-magnet, and in guiding the lower carbon holder by means of a wheel attached to its upper extremity and sliding loosely within the lining tube of the shunt solenoid, and of a wheel attached to an extension of the lamp, and bearing on the outside of the said carbon holder. 5 claims.

6,120. "Improvements in and relating to systems of electrical distribution." C. J. Kintner. Dated April 22nd. 8d. Has especially for its object to insure safety against accidents which arise through the use of high-tension currents of electricity in electric lighting and kindred electric systems. 16 claims.

3,544. "Improvements in and relating to electric telegraphy." F. J. Patten. Dated March 5th. 2s. Consists in a system in which progressive circuit closers are maintained in synchronism by electric motors having independent field magnet and armature circuits, one of which circuits in each motor is controlled by a line current changed periodically by reversal, or interruption, or otherwise, at periods corresponding to some part of the armature revolution, and the other circuit is excited by a current which produces in that circuit a suitable polarity either constant or periodically reversed, as may be required to maintain a continuous and uniform movement of the apparatus. Also consists in determining the rate of change in the controlling line current for synchronising the motors by the revolutions of a controlling motor, which sets the pace for the other motors of the system, and the other motors are so constructed, in respect to winding and connections, that they may be made to go at the same pace as this controlling motor or any fracton of its speed, as required; thus, the controlling motor may be run very fast and all the others very slow, but all the driven machines alike in speed and in unison with each other. Embodies also a novel method of signalling over the same line wire and a system of circuits and connections of apparatus such, that the synchronism remains uninterrupted, notwithstanding the frequent and repeated interruptions of the signalling current incident to numerous simultaneous transmissions over the same wire. 81 claims.

5,335. "Improvements in machines for insulating electrical conductors." H. H. Lake. (Communicated from abroad by C. T. Stetson, of America.) Dated April 8th. 8d. Consists of an improved machine for covering wire with a woven coating of insulating material. 7 claims.

5,343. "Improvements in telpherage systems." H. H. Lake, (Communicated from abroad by J. E. Maynadier, of America.) Dated April 8th. 8d. Consists mainly in the use of alternating currents in the main coils and in one or more coils which form part of the car. Also consists in a number of supports for the car so arranged that the weight of the car shall rest mainly upon one set of supports for a short time, and then upon another set for a short time and so on, the purpose being to prevent undue heating when the car travels at a very rapid rate. 2 claims.

CORRESPONDENCE.

Candle-Power.

In reply to your invitation for correspondence upon the subject of obscured lamps and diffusion of light, the following observations may be of interest:

In one room in my house I have found that a group of three 8 C.P. obscured lamps gives a much more useful light than one 50 C.P. clear lamp. In another room a group of eight 5 C.P. lamps gives an illumination unattainable by the same C.P. in a more concentrated form. The use of lamps of 8 and 5 C.P. increases the outlay and the cost of renewals as compared with lamps of higher power, but for the same amount of energy consumed, an effect is obtained which cannot be got from the larger lamps.

The effect is not peculiar to electric glow lamps, but may also be observed with incandescent gas burners and with oil lamps, the better qualities of which latter give a very brilliant flame. Remove an obscured globe from such a lamp, and the surroundings appear to be badly lighted. Replace the globe, and the surroundings, though in reality receiving less light, appear to be much better illuminated.

I do not think there is any mystery in these facts. The matter is simply one of contrast and of diffusion. If the source of light in an apartment be very much concentrated and very brilliant, the surroundings will appear, by the violent contrast, to be imperfectly lighted. The same, or even a smaller amount of light presented in a less brilliant and less concentrated form, allows the eye to appreciate the illumination of the apartment and its contents.

With regard to diffusion, the plane and curved surfaces of articles in a room present themselves at all imaginable angles. The more the sources of light are multiplied, the better chance has each portion of a surface to receive some light at the angle best adapted for its efficient illumination. An obscured lamp not only reduces the violence of the contrast before mentioned, but so increases the size of the source of light as to materially aid in multiplying and spreading the points from which the rays of light proceed. If, in addition to obscuring the lamps, their number be increased, and their power be proportionately reduced, the result will be still more satisfactory for the same expenditure of energy.

Henry Lea.

January 26th, 1891.

Permit me to address you the following letter, to explain some remarks you made in an article headed "Candle-Power."

For the want of a simple standard of "brightness," I employ the word "intensity" as a comparative one. In the case of gas and the incandescent filament, the latter has a greater intensity than the former when burnt in the ordinary way. That is to say, any point in the incandescent carbon is brighter than any point in the gas flame. By "diffusion" I mean absence of sharp, dark shadows. Small areas of light produce these, also comparatively large areas, if of great brilliancy. It is possible to obtain a simple expression for the value of diffusion, and your suggestion will be acted upon. To find practical values, I would suggest the following method. Having lighted an area—say, a room—in a manner which would please most people—not everyone, for this is to expect too much—the difference in light between the lighted and shadowed parts of the room must be ascertained. Suppose the ratio were to come out as 1 is to 10, then 0·1 or 10 will express a well-lighted room. The colour of the light enters somewhat into the problem, so that some function must be combined with it. I am about to give attention to this latter question, to find a simple method of investigation open to the uninitiated, without spectrum analysis in the usual sense.

David Salomons.

January 26th, 1891.

Magnetic Influence on Incandescent Lamps Filaments.

With reference to Mr. Hewlett's letter which appears in your issue of the 16th inst., I may state that the officials of the Brush Electric Company who were connected with the incandescent department at the time it was carried on under my superintendence, are perfectly familiar with the "spreading" property of filaments when flashing them under magnetic influence. In this process the filaments were "clipped," so as to lie in a horizontal position, and on passing the gradually increasing current, they would droop downwards through the action of gravity, unless supported by means of a magnet placed opposite the crown of the filament. An electro-magnet, of horseshoe form, was ordinarily employed for this purpose, and was held so that one pole was above the other; the incandescent filament at once placing itself between the poles, and inclining, either upwards or downwards, according to whether the magnet was held a little above or below the straight line. Whilst the operation proceeded, the shape of the filament would gradually alter more or less (according to conditions), spreading outwards in consequence of an evident repulsion from the magnet. The conditions favourable to the spreading or bulging of filaments under magnetic influence are:—a small gauge, a considerable length, a powerful magnet, a short distance between the crown of the filament and the magnet, and a high temperature. This latter condition includes that of a strong current relatively to the mass of the carbon, and this point is, doubtless, an important factor in the effect produced. The description of carbon is also an important feature in this connection, the hard varieties being less liable to bend than the softer and more porous descriptions. I can remember some instances of certain filaments for lamps of high resistance and small candle-power, where the loops have disappeared entirely, and a distorted balloon-shaped article was the final form. Of course the loop-shaped filaments are more easily affected than those with the simple ∩, but the latter alter also, under favourable conditions, and become flatter at the crown, and assume a conical shape.

It is clear from the above remarks that carbon in a heated condition is in a somewhat loose, pliable state, and is capable of being easily and permanently bent, when subjected to a strain, like a stick of warm sealing wax, and it does not regain its rigid, elastic property until at a comparatively low temperature. In fact, I recollect hearing that some Continental lamp manufacturers availed themselves of this semi-mobile property of carbon at high temperatures to shape long, straight carbonised filaments into suitable forms for lamps. The manufacturers of the formerly much talked of Cruto lamp must also be familiar with these properties, for their filaments were flashed under magnetic influence.

I may add that I incidentally alluded to these phenomena in a foot-note of an article on "Different Sectional Heating of Incandescent Lamp Filaments," which appeared in the Electrical Review for October 5th, 1888.

Legh S. Powell.

January 24th, 1891.

Chromic Acid Battery.

In your issue for January 9th, 1891, a correspondent enquires the best proportions of materials for a chromic acid battery. I would draw his attention to a short paper on this subject which was read by Mr. Joseph Wilson Swan, M.A., before the British Association Meeting of 1889.

The best depolarising solution arrived at after considerable experiment consisted of:—

Nitric acid (sp. gr. 1·42) ...	1	part by weight.
Chromic acid...	3	" "
Sulphuric acid...	6	" "
Water	5	" "

The chromic acid is first dissolved in the water, the nitric acid is next added, and finally the sulphuric acid.

To secure constancy of current, a small amount of nitric acid is absolutely necessary; but in the above mixture the quantity is so small that no inconvenience arises from fuming at any period or rate of the discharge.

It should be remarked that the mixture in question only applies when carbon is used as the electrode in the depolarising compartment; if platinum is employed a larger proportion of nitric acid is required.

Legh S. Powell.

January 24th, 1891.

The Berlin Telephone Service.

Again I am called upon to correct a statement made in your valuable periodical, of which I am a regular reader, concerning telegraph and telephone institutions in this country. In your issue of January 9th, p. 54, you say that the establishment of an underground network for the Berlin telephone service is about to be proceeded with. Now this establishment, begun in 1889, has been an established fact for the last six months. There are 34 kilometres of pipes laid out, each of which holds as many as 90 lead-covered telephone cables, each of them containing 28 wires. More than 4,000 subterranean wires, representing a total length of 1,600 kilometres, are being worked already, and every day witnesses new additions to the underground net. The example of Berlin will be followed up by similar establishments in the other large cities of the Empire. Particulars are to be found in the *Elektrotechnische Zeitschrift*, d. d. October 17th, 1890, p. 558. I make bold enough to add that I should be glad if this hint would be productive of the good that your contributors might do better to glean facts from a contemporary instead of squabbling over the erroneous promotion of Mr. Swinburne to the title of "Professor" in one of your former issues.

F. Hennicke.

Berlin, W., 23*rd January*, 1891.

Varying Resistances of Bad Conductors.

The following passage appears in a contemporary:—"Mr. Branly has recently found that the spark of a Holtz machine or induction coil has a remarkable effect in temporarily decreasing the resistance of certain badly-conducting mixtures, such as powdered or oxidised metals or pastes formed by immersing filings of iron, copper or other metals in a non-conducting fluid." I would ask you to kindly allow the following cutting from a published abstract of a paper read by me at the Liverpool meeting of the British Association in 1870 to appear in the next issue of the ELECTRICAL REVIEW.

"The author, when experimenting with electric currents of varying degrees of tension, observed the very great resistance with a loose mass of powder of conducting matter opposed to the passage of electricity of moderate tension; he found with a tension of fifty Daniell cells electricity did not pass through a loose mass of finely divided black lead or wood charcoal. When the tension was increased to two or three hundred cells, the particles arranged themselves by electrical attraction, making good electrical contact, and formed a bridge by which the electricity freely passed. With a tension of six or seven hundred cells the electricity was found to pass through a considerable interval of the dust met with in rooms, which consists chiefly of silica and alumina, with more or less organic and earthy matters.

"Incandescent matter offers a very free passage to electricity; masses of highly heated black lead powder were found with six cells to give an average resistance of five units, or about one-sixtieth of that opposed by an ordinary needle-telegraph coil, which may be taken at 300 units. These experiments went to show that an interval of dust separating two conductors opposes practically a decreasing resistance to an increasing tension, and led to the construction of the "Lightning-bridge," which consists of two pointed conductors, enclosed in a chamber, and approached to within one-eighteenth of an inch from one another, and surrounded with finely divided matter consisting of carbon and a non-conducting substance intimately mixed in suitable proportions determined by electrical tests. The reason why a powder consisting entirely of conducting matter cannot be safely employed is, that although it may oppose a practically infinite resistance to the passage of electricity of the tension of ordinary working currents, when a high tension discharge occurs, the particles under the influence of the discharge generally arrange themselves so closely as to make a conducting connection between the two points of the lightning-bridge."

S. Alfred Varley.

Mr. S. A. Varley on Mr. Crookes's Address.

In Mr. Varley's article of last week, he hardly seems to have treated the molecular theory of gases with his usual amount of fairness; but would he give me, as one interested in his usually extremely original writings and as a student, a little information on the following.

His main argument against this theory is that, according to its teachings, the molecules must after a certain number of oscillations and impacts, lose whatever energy was before possessed by them, in friction, the gas consequently losing its elastic properties, and therefore failing to answer to the known laws of gases.

But this view pre-supposes that no heat or other form of energy can be transmitted to any of the molecules, and that no transference of energy can take place from the energised molecules to those which are spent. I am not aware of any theorist ever having stated that under these conditions of complete isolation the gas would still retain its elastic or "molecule bombarding" properties. In fact, with complete isolation, would the result not logically follow, either that the heat of the gaseous molecules is nil, and that being isolated they can obtain none; or that the molecules having a store of energy in heat or other form, would be unable to lose any of this energy owing to their position of isolation, and consequently would bombard for ever. In the first case of utter absence of heat, the free path of the molecules would be nil. When it would immediately occur that the gas would lose its gaseous form and become a fluid.

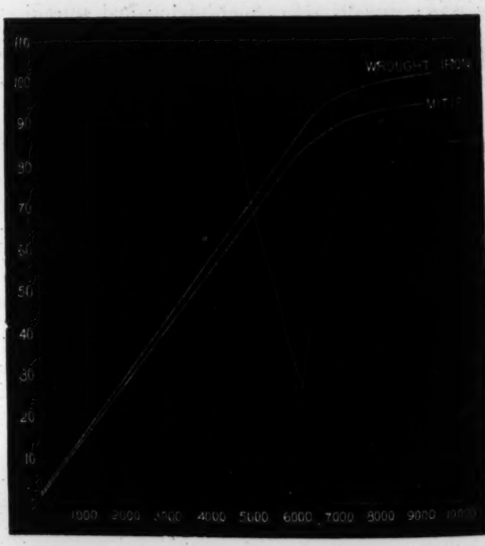
Mr. Varley speaks of the + pole of an induction coil. Of course, the secondary without special apparatus would produce alternating currents.

N. S.

Mitis Metal for Dynamo Magnets.

I notice the question of mitis metal for dynamo magnets has lately been agitated in your columns.

In 1887 I made a dynamo with mitis metal magnets, which was noticed in your issue of June 10th or 17th of that year. I had a set of wrought iron magnets made as well, exactly similar to the mitis ones, and took two curves off the machine. The conditions in each case were the same, the same armature was used, and the readings were taken with Sir W. Thomson's graded galvanometers.

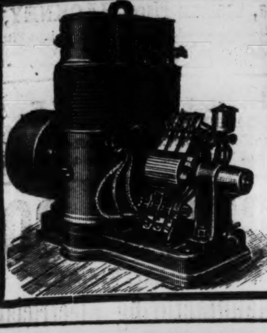


I enclose you a copy of the two curves, which may be interesting to those of your readers who are thinking of trying mitis.

Claude W. Hill.

January 27*th*, 1891.

P. FORD.—You will find descriptions of automatic electric railway signalling in "The Applications of Electricity to Railway Working," by W. E. Langdon; published by Macmillan. For fuller information you would have to search the records at the Patent Office Library, as there is no other book that we are aware of which deals with the subject.



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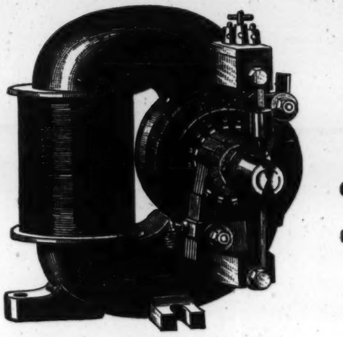

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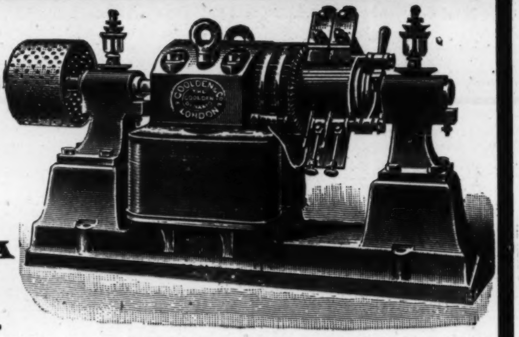

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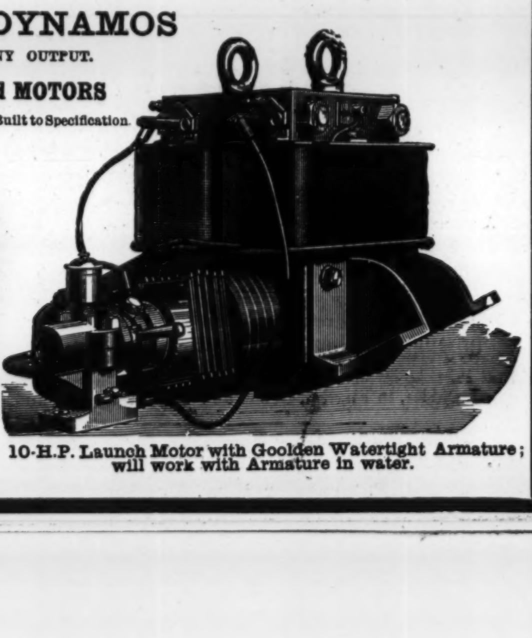

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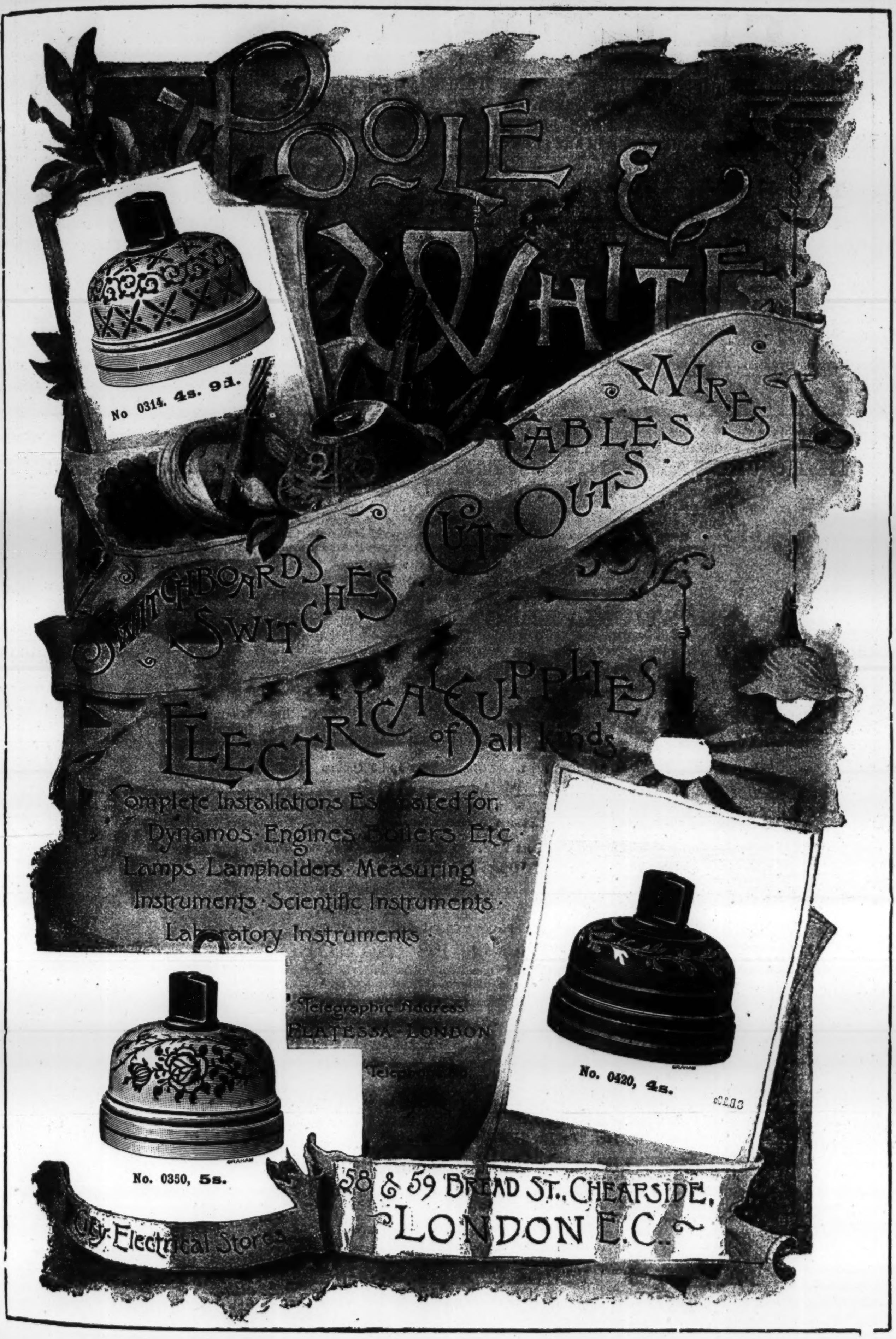

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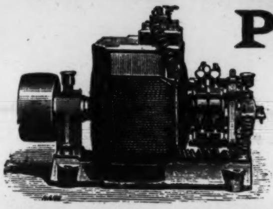

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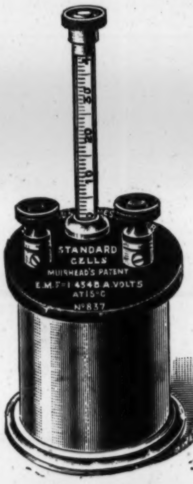

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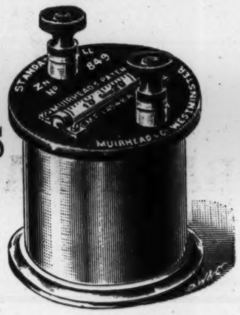

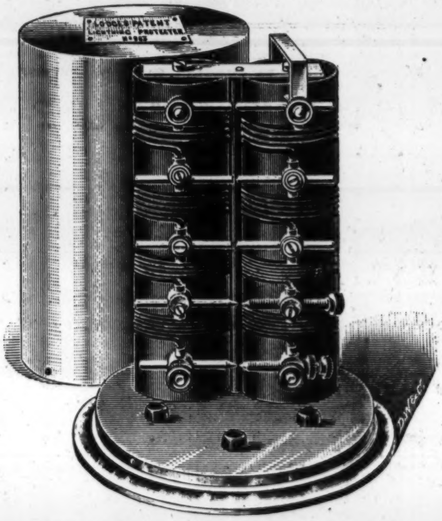

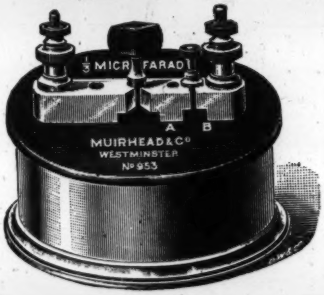

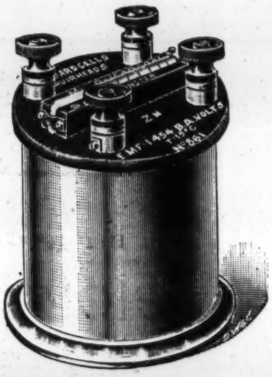

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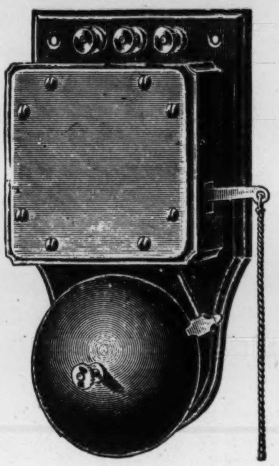

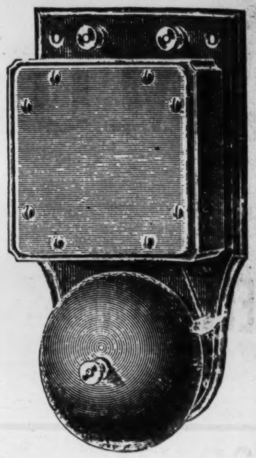

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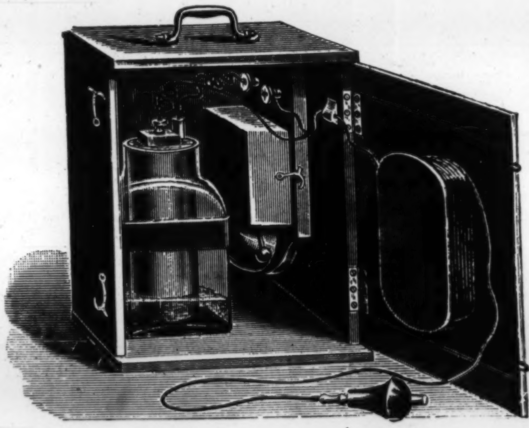

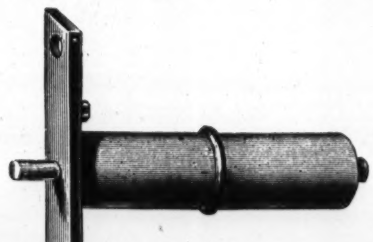

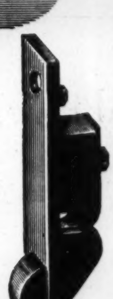

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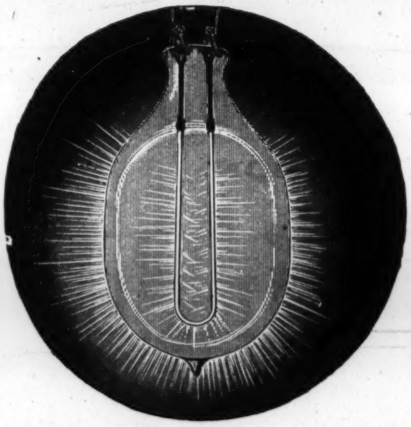

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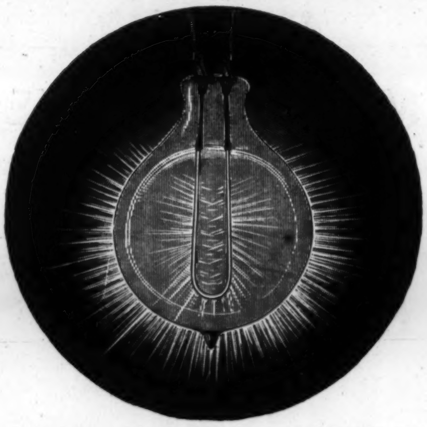

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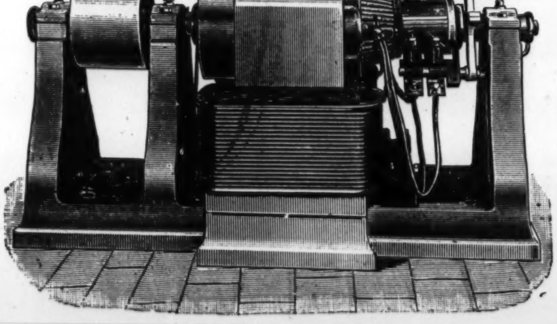

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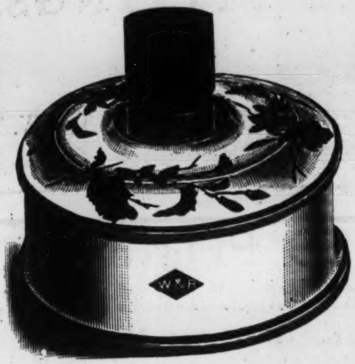

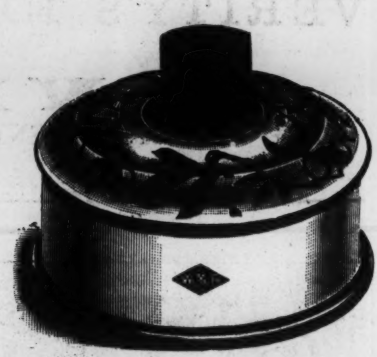

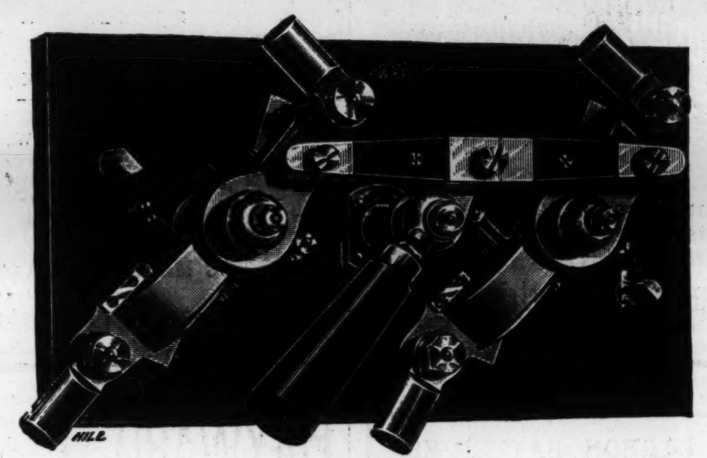

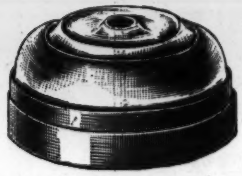

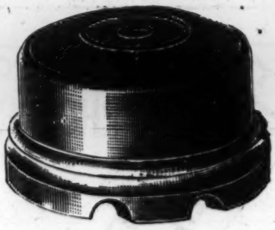

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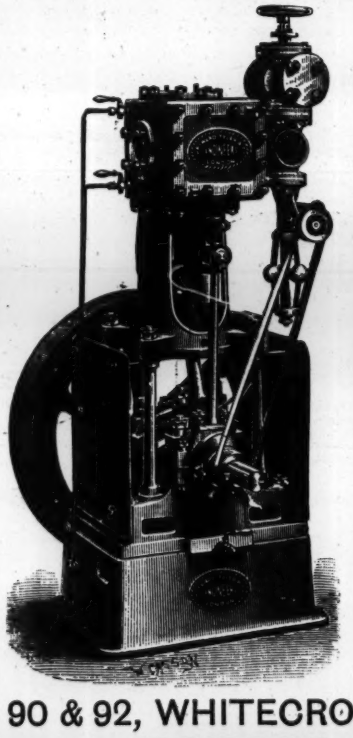

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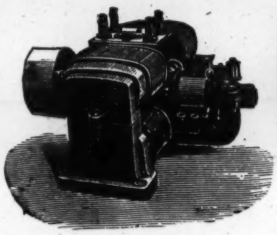

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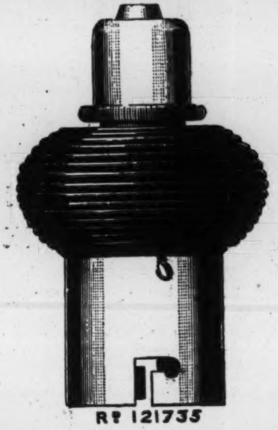

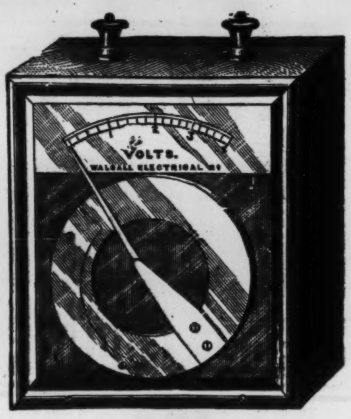

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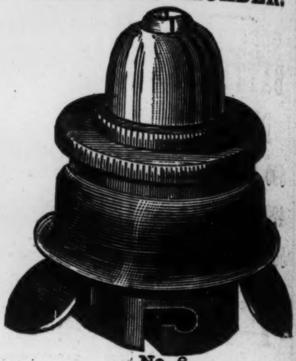

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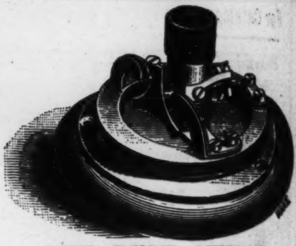

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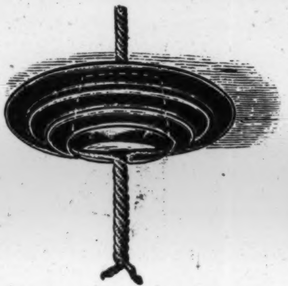

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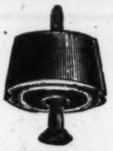

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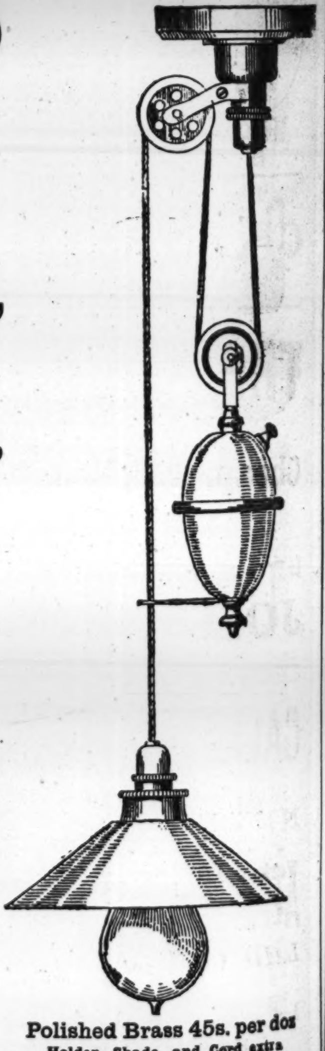

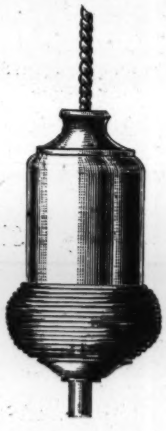

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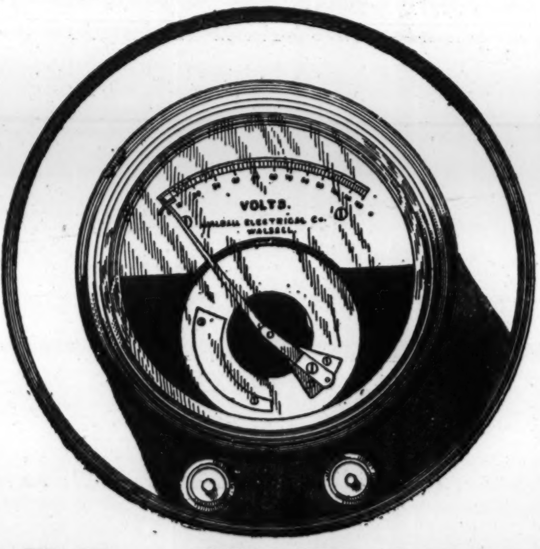

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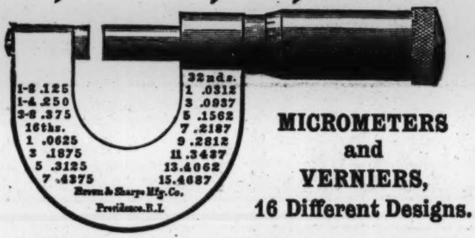

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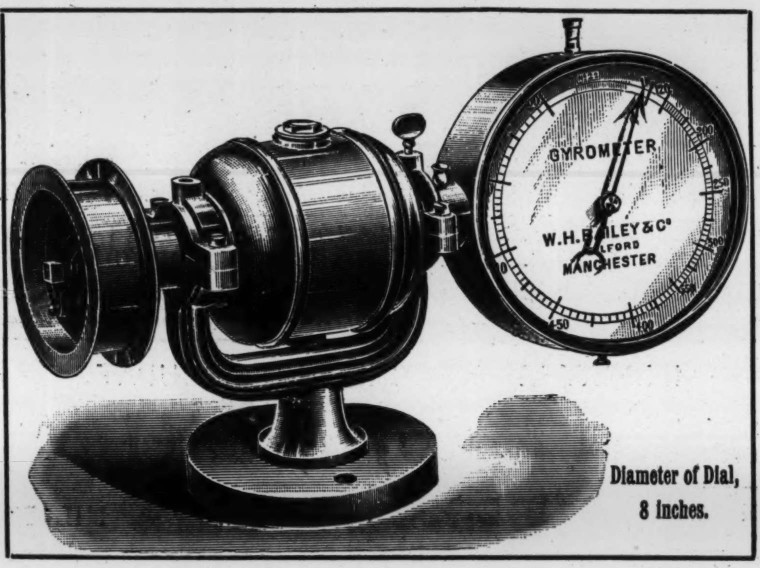

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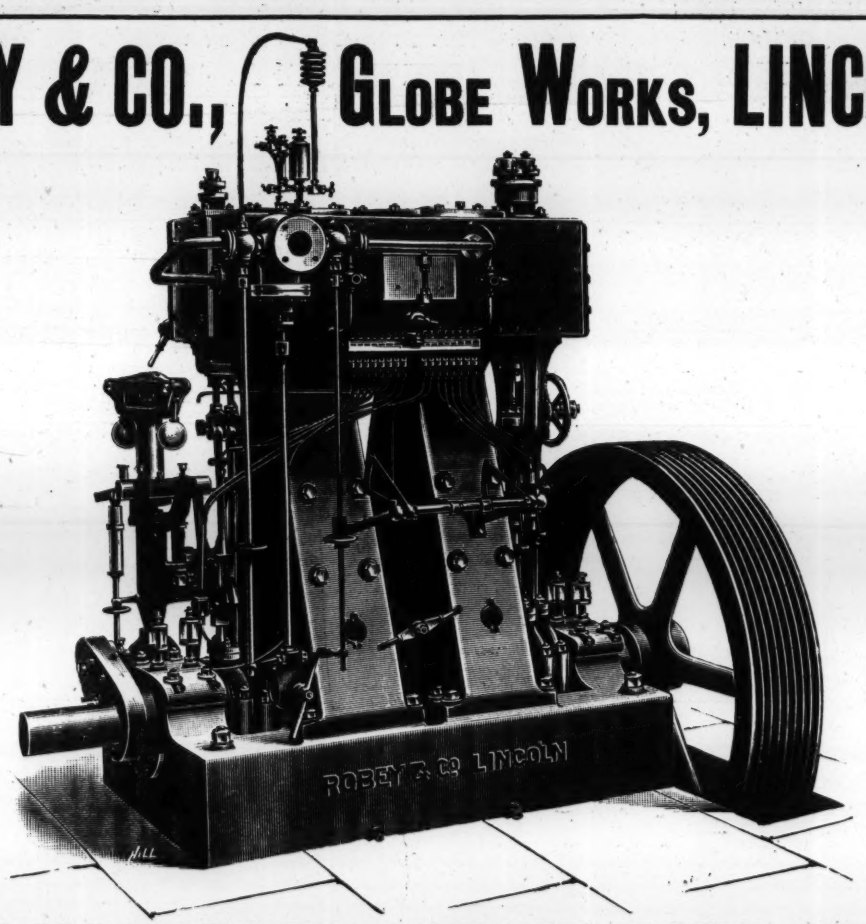

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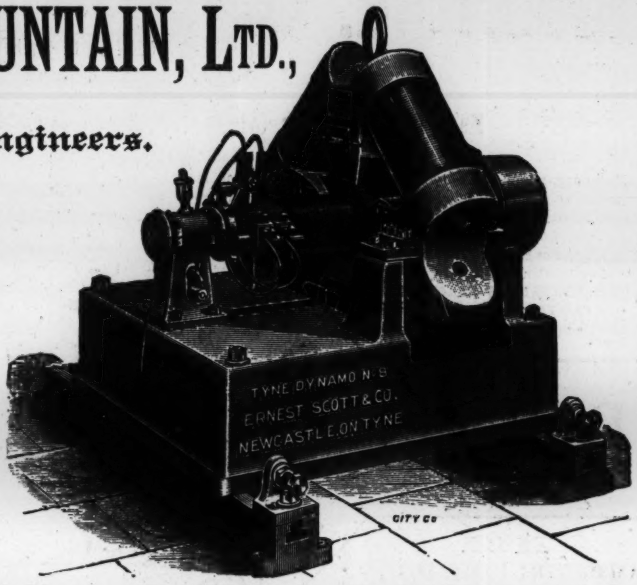

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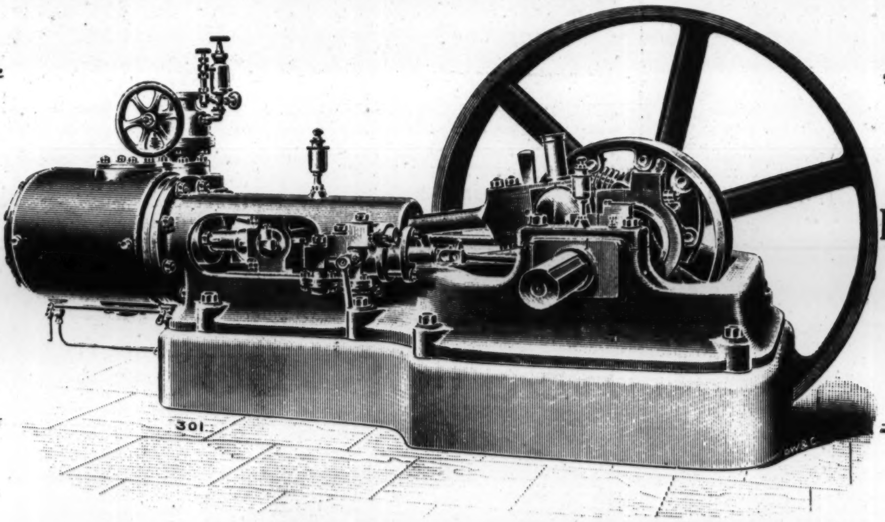

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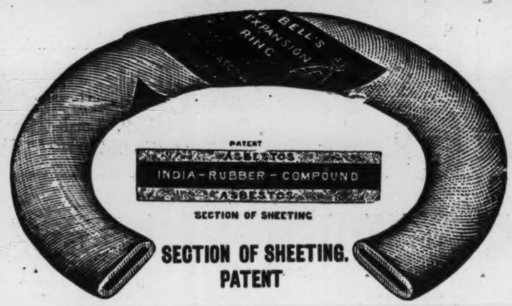

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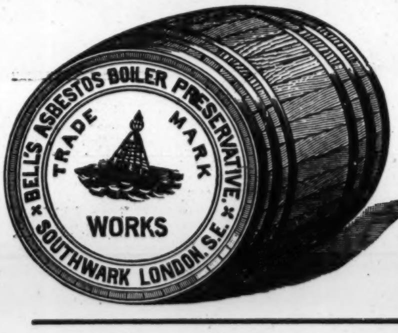

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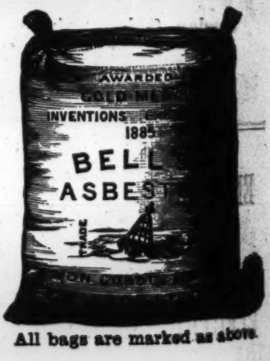

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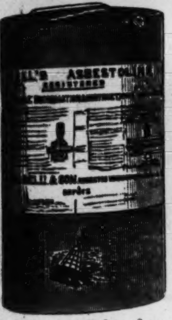

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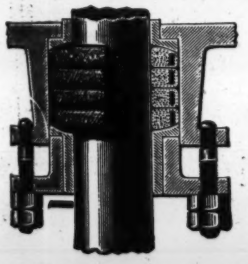

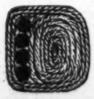

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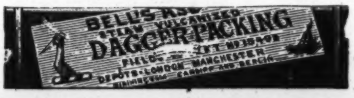

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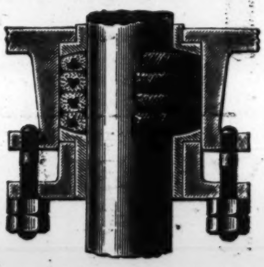

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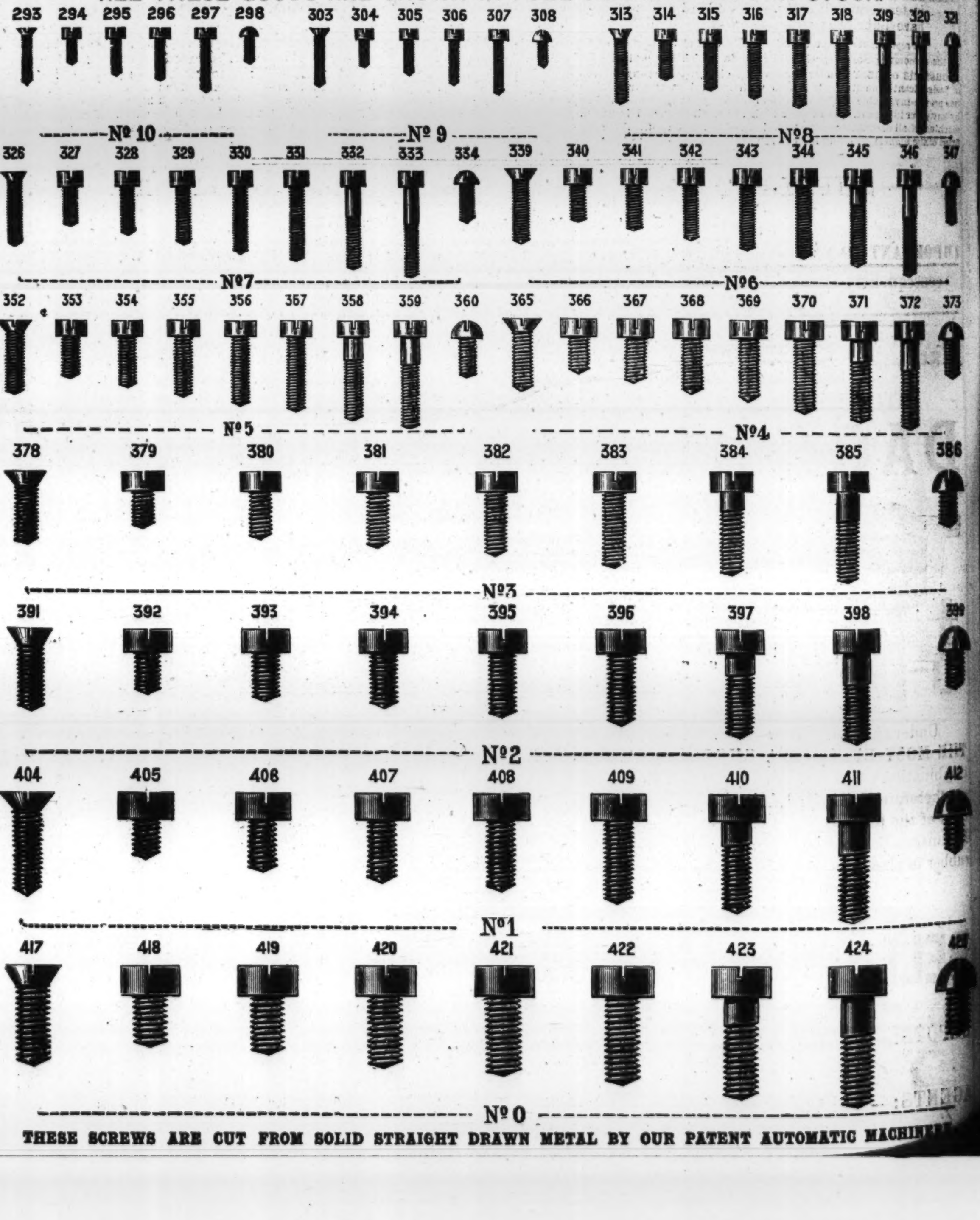

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